Communication Protocols
2021-2022

Lab Assignment 4 – OSPF

Objectives and organisation

The objective of this lab assignment is to explore the configuration and use of OSPF. This interior routing protocol is more elaborate than the RIP protocol, which was the subject of the previous lab assignment. Despite its complexity, OSPF can be easily and quickly configured in small networks.

This lab assignment should be carefully studied and prepared before executing it in the lab. The total estimated time for the lab assignment, including off-class study, is 8 hours. There are guided exercises, for which the commands/actions to execute are presented and explained, and proposed exercises that should be done autonomously by the students.

The following topics are addressed in the lab assignment:

- Basic configuration and use of the Open Shortest Path First protocol (OSPF) in Cisco-based networks
- OSPF route summarisation
- Redistribution of routes originated by other protocols

Throughout the execution of the lab assignment, commands output and configuration files should be kept for inspection by the teacher. Special attention should be given to their interpretation and explanation.

The current lab assignment may require cooperation between groups in order to setup the scenarios under study. More than the sheer configuration of individual routers, it is important to interpret, explain and understand the behaviour in the overall network scenario. This is a key element for evaluation.

The following aspects will be taken into account when evaluating the work:

- Preparation of the lab assignment – 10%
- Knowledge of the aspects under consideration – 30%
- Exercises execution – 50%
- Group autonomy – 10%

1. Basic OSPF configuration

The basic configuration of OSPF is quite simple. The 'router' command is used to establish the protocol to use and the number of the corresponding process. Then, the 'network' command is used to identify the networks to be announced by OSPF and their respective area.

Consider the sample scenario depicted in Figure 1.

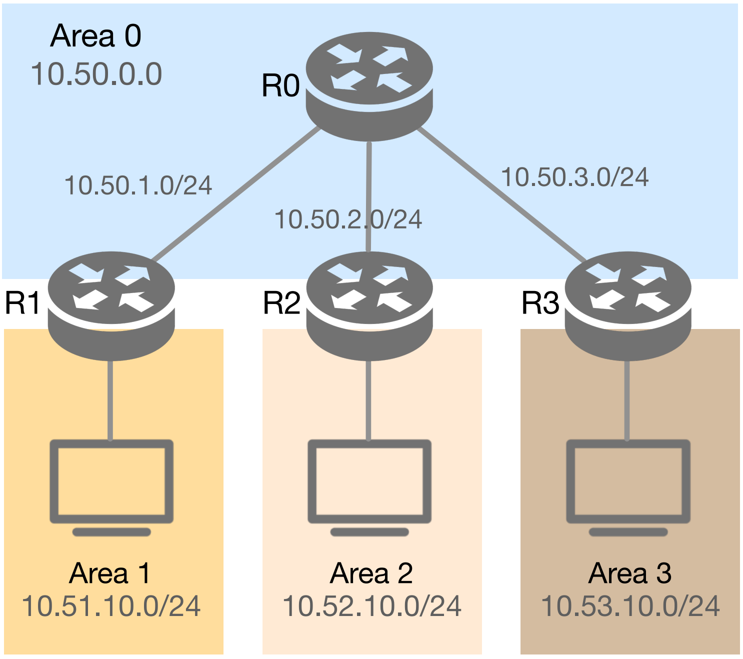


Figure 1 – Sample OSPF scenario

R0 is a Backbone Router (BR), as all of its interfaces are in the backbone area. In OSPF, the existence of the backbone area is mandatory and its ID must be 0. R1, R2 and R3 are Area Border Routers (ABR) and, thus, one of their interfaces is in the backbone area and the other interfaces are in other areas to which they are connected.

The following is an extract of the OSPF configuration of each of these routers:

R0 router:

```
router ospf 100
 network 10.50.1.0 0.0.0.255 area 0
 network 10.50.2.0 0.0.0.255 area 0
 network 10.50.3.0 0.0.0.255 area 0
```

R1 router:

```
router ospf 100
 network 10.50.1.0 0.0.0.255 area 0
 network 10.51.10.0 0.0.0.255 area 1
```

R2 router:

```
router ospf 100
 network 10.50.2.0 0.0.0.255 area 0
 network 10.52.10.0 0.0.0.255 area 2
```

R3 router:

```
router ospf 100
 network 10.50.3.0 0.0.0.255 area 0
 network 10.53.10.0 0.0.0.255 area 3
```

The purpose of the '100' number following the 'router ospf' command is solely to identify the process inside the router. This is a local number and, thus, is not propagated to other routers. Thus, it can take any value and there is no need for it to be the same in every router.

Exercise 1 – Based on the previous example, configure the OSPF scenario of Figure 2. In the penultimate page of the current document you can find a reproduction of the scenario presented in Figure 2. Use this page to define the connections and addressing plan. Use the private address spaces identified in the figure. Ask the teacher the value to use for X.

- Each group will be responsible for one OSPF area, with the exception of the backbone area, which should be the joint responsibility of all groups class.
- After setting up the scenario of Figure 2, do the following:
  - Get the routing table of the R0 router and of your group's router, using the 'show ip route' command in each of these routers.
  - Obtain the list of neighbour routers for the cases of R0 and of your group's router, using the 'show ip ospf neighbor' command in each of these routers.
  - Check the connectivity between the various sub-networks, using the 'ping' command.
- Analyse and interpret the obtained results.

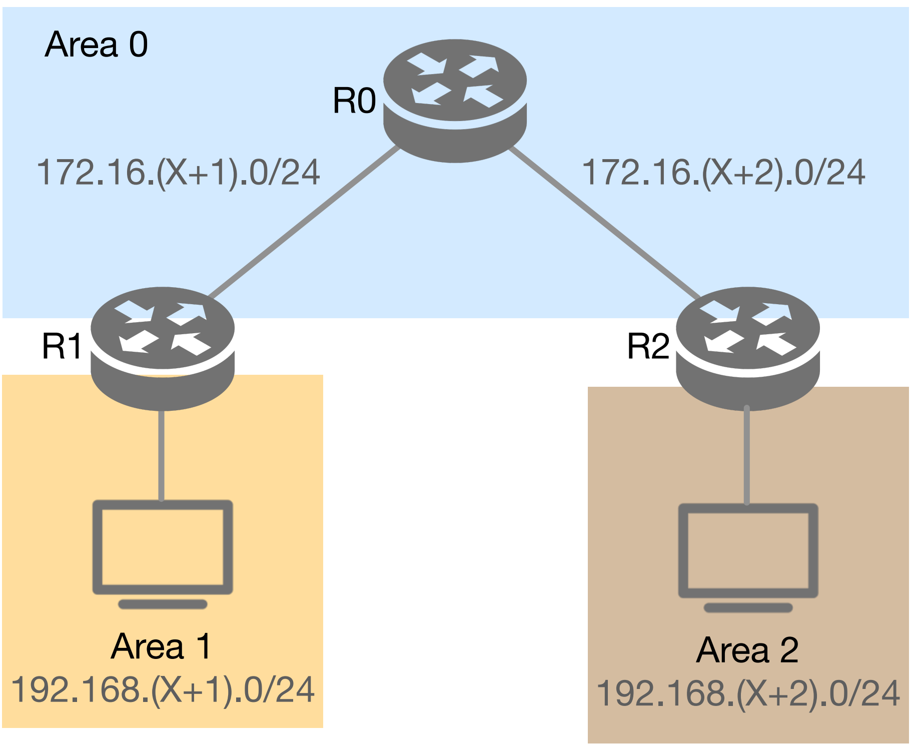


Figure 2 – Basic OSPF scenario

2. Route redistribution in OSPF

The connection of domains not using OSPF and the redistribution of routes not originated by OSPF inside the OSPF autonomous system is made possible by the use of the NSSA (Not-So-Stubby-Area) concept.

In the following example, illustrated in Figure 3, R1 is an ABR router which connects the backbone area to Area 1. On the other side, R2 is running the RIP protocol on one of its interfaces. We intend to redistribute by OSPF all the RIP-originated routes of R2.

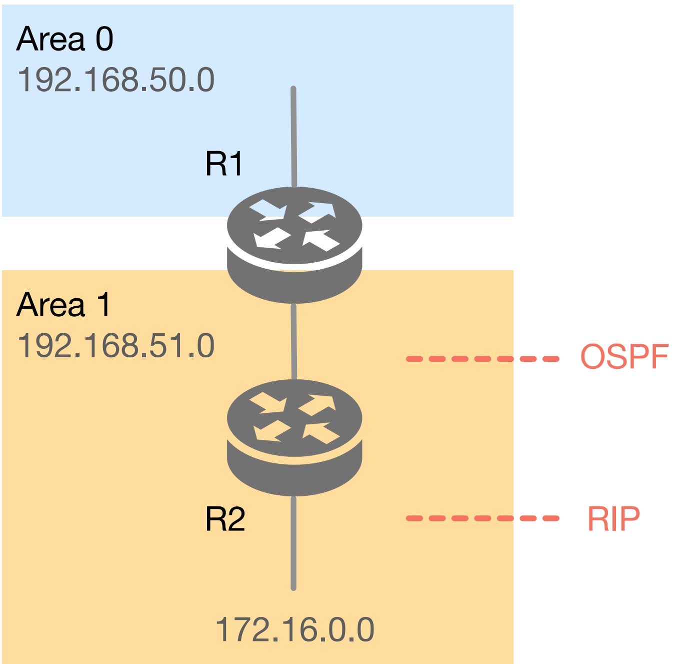


Figure 3 – Example of NSSA area

The following is an extract of the routing configuration of each of these routers:

R1 router:

```
router ospf 100
 network 192.168.50.0 0.0.0.255 area 0
 network 192.168.51.0 0.0.0.255 area 1
 area 1 nssa
```

This is a simple OSPF confiduration, which identifies the area associated with each of the networks. Additionally, Area 1 is declared as an NSSA area.

R2 router:

```
!
! RIP configuration
router rip
 network 172.16.0.0
!
! OSPF configuration
! indicating that RIP routes are to be redistributed
router ospf 100
```

```
redistribute rip subnets
network 192.168.51.0 0.0.0.255 area 1
area 1 nssa
```

Note that R2 needs to run RIP and OSPF. This router injects the RIP-originated routes into OSPF, so that R1 only needs to deal with OSPF routes.

Exercise 2 – Based on the previous example, setup the scenario depicted in Figure 4, in which RIP routes are being injected in the OSPF areas. In the last page of the current document you can find a reproduction of the scenario presented in Figure 4. Use this page to define the connections and addressing plan. Use the private address spaces identified in the figure.

- After setting up the scenario of Figure 4, do the following:
  - Get the routing tables of the R0 router, of the ABR router in the NSSA area, of the RIP router in the NSSA area, and of the ABR router in the standard area, using the 'show ip route' command in each of these routers.
  - Check that the routes injected by RIP show up in the routing tables.
  - Check the connectivity between the various sub-networks, using the 'ping' command. In particular, check the connectivity with the RIP networks.
- Analyse and interpret the obtained results.

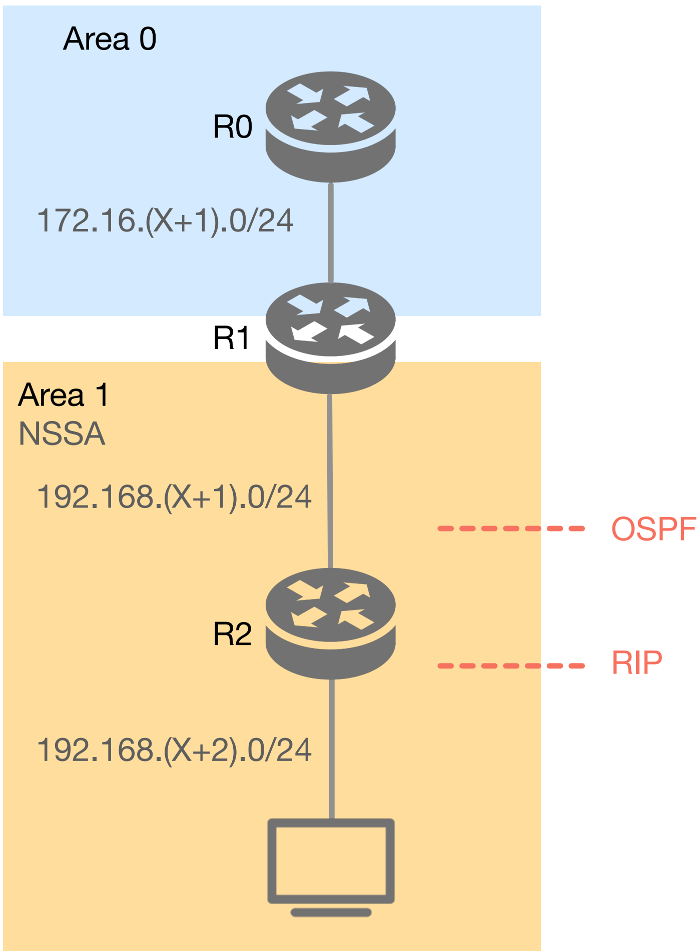


Figure 4 – OSPF scenario with RIP routes redistribution

3. Route summarisation

In exercise 2 it was possible to see that there was a separate entry in R0's routing table for each of the networks in area 1. Although this is not a problem, it leads to routing tables with more entries than necessary.

ABR routers can summarise (i.e., aggregate) the routes that they announce as long as they are contiguous routes. This can be done through the 'area range' command, as illustrated in the following example that uses the scenario depicted in Figure 5.

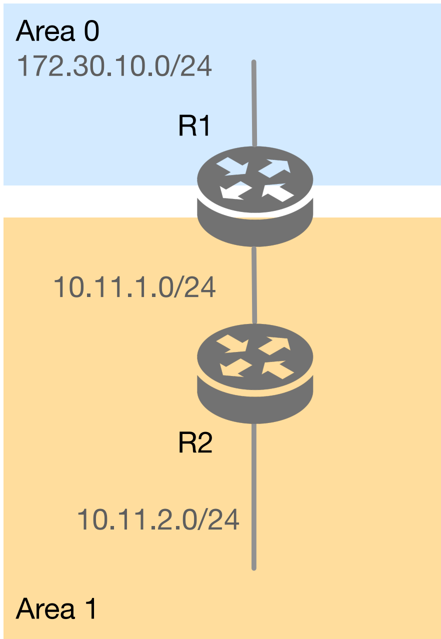


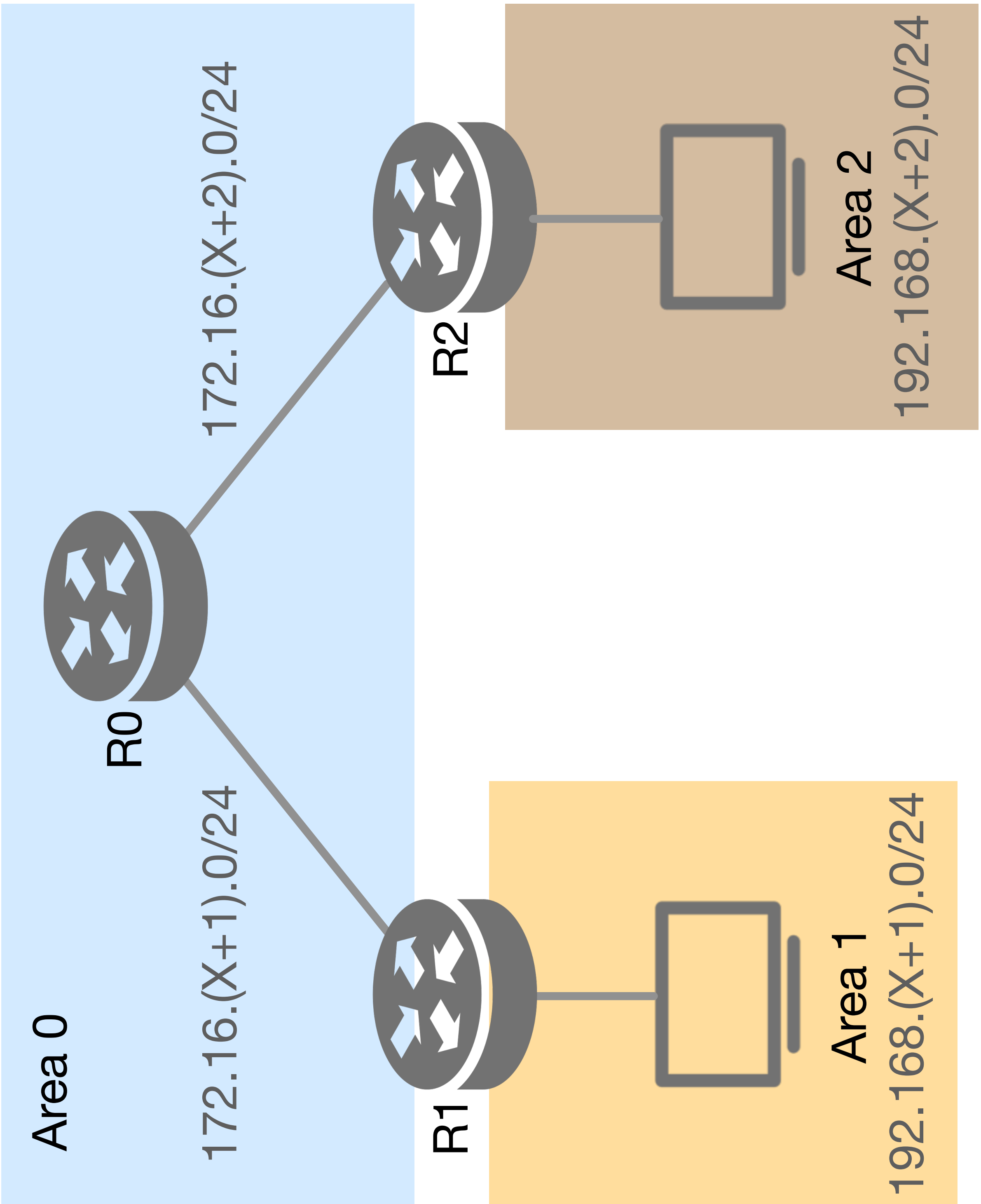
Figure 5 – Route summarisation scenario

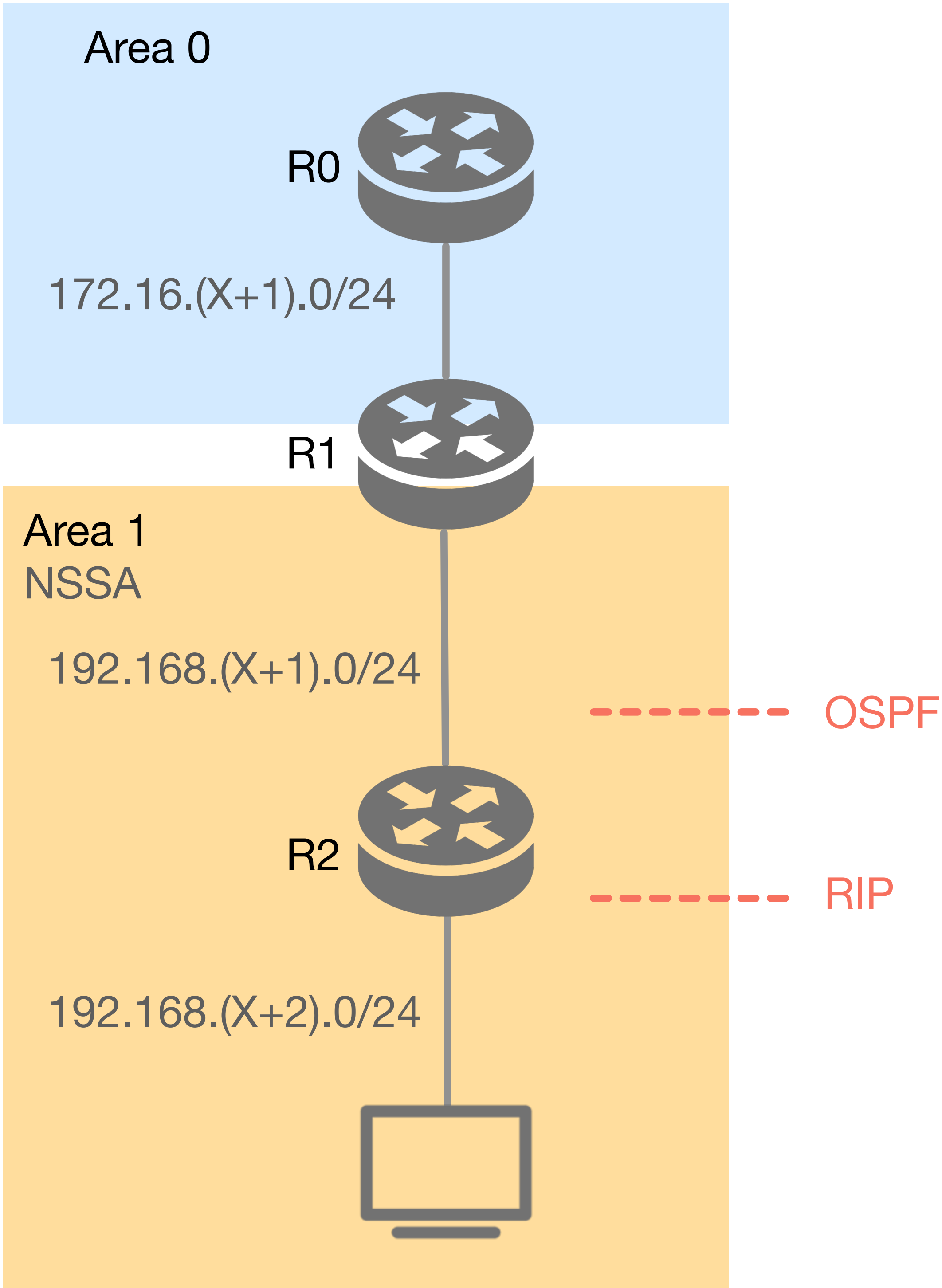
R1 router configuration:

```
router ospf 100
 network 172.30.10.0 0.0.0.255 area 0
 network 10.11.1.0 0.0.0.255 area 1
 ! area 1 route summarisation command
 area 1 range 10.11.0.0 255.255.0.0
```

Exercise 3 – Based on the previous example, and using the topology presented in Figure 4, do the following:

- Configure the scenario in order to use OSPF only (this means that R2 will not announce any network through RIP and that area 1 will no longer be an NSSA area).
- Set up route summarisation in area 1.
- Get the routing tables of all routers, using the 'show ip route' command in each of them.
- Compare these routing tables with the ones obtained in Exercise 2. Which routes have been summarised?
- Analyse and interpret the obtained results.


Area 0
172.16.(X+2).0/24
172.16.(X+1).0/24
R0
R1
R2
Area 1
192.168.(X+1).0/24
Area 2
192.168.(X+2).0/24


Area 0
R0
172.16.(X+1).0/24
R1
Area 1
NSSA
192.168.(X+1).0/24
OSPF
R2
RIP
192.168.(X+2).0/24