Redes de Computadores (RCOMP) – 2017/2018

Laboratory Class Script – PL18

• Autonomous systems • Autonomous systems interconnection – routes redistribution.	• Cisco Packet Tracer

1. Autonomous Systems

We already have a fair idea why autonomous systems are required. Routeing protocols are very useful in building and keeping routeing tables updated, and thus, providing fault tolerance and even network load balancing. Yet, the number of networks managed by a routeing protocol deployment has to be restrained.

As the number of networks increases, some performance issues will arise:

- Routeing tables get bigger.
- Convergence time gets longer.
- Routeing protocol traffic increases.

To avoid these problems, limits to routeing protocols propagation are settled. These limits define an autonomous system.

An autonomous system is an infrastructure zone, made of several interconnected networks, in which a routeing protocol is deployed to dynamically manage routeing tables. We can also say an autonomous system is a set of adjacent networks, networks outside the autonomous system will not be included in its routeing tables.

1.1. Autonomous System Boundary Router (ASBR)

Autonomous systems limits are enforced by routers. Routers with this role are called Autonomous System Boundary Routers. An ASBR is a normal router, however, its network interfaces are not all assigned to the same autonomous system.

A router is able to handle with different autonomous systems, either because, they use different routeing protocols (e.g. RIP and EIGRP), or because they use a same routeing protocol, but with a different autonomous system identifier.

RIP (Routing Information Protocol) lacks any autonomous system identification, this doesn't mean it can't be used to create an autonomous system. The only constrain around RIP based autonomous systems is that they cannot be adjacent. This is so because it´s not possible to have two RIP autonomous systems connected to the same router, they would simply become the same.

1.2. Autonomous System Number (ASN)

Several routeing protocols identify autonomous systems by numbers, known as autonomous system numbers.
Currently, Border Gateway Protocol (BGP) is the standard exterior gateway protocol over the internet. BGP border routers connect local autonomous systems to the internet, each local autonomous system has an IANA assigned ASN. Originally BGP ASNs where 16-bits numbers, but have now been upgraded to 32-bits numbers.
EIGRP also requires a 16-bits ASN, although not related do BGP ASNs, they serve the same purpose of identifying an autonomous system.
EIGRP ASN numbers can be from one up to 65535. They allow an autonomous system boundary router to be connected to several different EIGRP autonomous systems, as far as each uses a different ASN.

1.3. OSPF area numbers

OSPF is somewhat different, but after all, equivalent. A set of adjacent networks being managed by OSPF is an **OSPF Domain**. Under other routeing protocols perspective, one OSPF Domain is one autonomous system.

We should emphasise **adjacent networks**, otherwise it will no longer be a single OSPF Domain. This issue can though be overcome, by using virtual links between routers (an advanced feature of OSPF configuration no being detailed here).

At first glance, it looks pretty the same as RIP. Nevertheless, an OSPF Domain can be divided into OSPF areas.

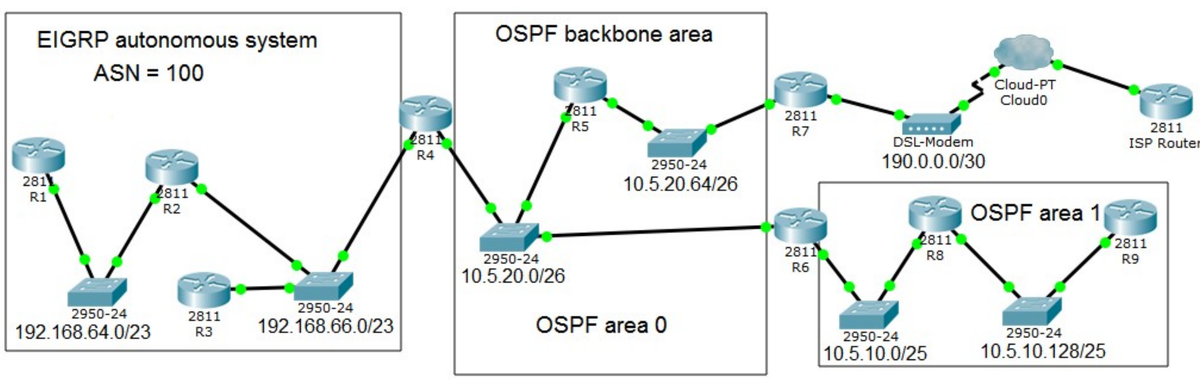
Some autonomous systems goals are shared with OSPF areas, namely, reduce routeing tables' length, routeing protocol traffic and the convergence time. Like with an autonomous system, an OSPF area should also be made of a single IP addresses block. The main difference is that, unlike what happens between autonomous systems, routeing information is automatically forwarded between OSPF areas.

Each OSPF area is identified by 32-bits number, they are sometimes presented in dot-decimal. The first area to be created must be area zero (0.0.0.0), it's known as **backbone area**. Other areas must be physically adjacent (or virtual linked) to the backbone area.

Area Border Routers (ABR) are routers with one interface attached to the backbone area and other interfaces attached to other areas, they ensure automated routeing information transfer between areas.

2. Practical exercise

Create the following routers and layer two devices diagram on Packet Tracer.
(This diagram is available for download with already settled IP addresses)



IPv4 network addresses are presented at the image, below layer two devices.

2.1. Assign a valid IPv4 node address to every router's interface (only if starting from scratch).

Concerning the ISP router connection, assign to it address 190.0.0.2/30. Assign router R2 in 192.168.66.0/23 network, the 192.168.66.1 address. Others assign at your will, as far as they are valid.

2.2. Setup the EIGRP autonomous system presented at the image.

Router R4 is going to play an ASBR (Autonomous System Boundary Router) role, therefore, only one interface belongs to the autonomous system.

R1	R2
(config)#router eigrp 100 (config-router)#no auto-summary (config-router)#network 192.168.64.0 0.0.1.255	(config)#router eigrp 100 (config-router)#no auto-summary (config-router)#network 192.168.64.0 0.0.1.255 (config-router)#network 192.168.66.0 0.0.1.255
R3	**R4**
(config)#router eigrp 100 (config-router)#no auto-summary (config-router)#network 192.168.66.0 0.0.1.255	(config)#router eigrp 100 (config-router)#no auto-summary (config-router)#network 192.168.66.0 0.0.1.255

2.3. Setup OSPF areas 0 and 1 as presented at the image.

Again, router R4 is going to play an ASBR (Autonomous System Boundary Router) role, therefore, only one interface belongs to OSPF area 0.

Router R6 will be an area border router (ABR), one interface will be on area 0 and the other in area 1.

Router R7 will also be an ASBR, although it will be connected to a single autonomous system.

R4 (config)#router ospf 5 (config-router)#network 10.5.20.0 0.0.0.63 area 0	R5 (config)#router ospf 5 (config-router)#network 10.5.20.0 0.0.0.63 area 0 (config-router)#network 10.5.20.64 0.0.0.63 area 0
R6 (config)#router ospf 5 (config-router)network 10.5.20.0 0.0.0.63 area 0 (config-router)#network 10.5.10.0 0.0.0.127 area 1	R7 (config)#router ospf 5 (config-router)network 10.5.20.64 0.0.0.63 area 0
R8 (config)#router ospf 5 (config-router)network 10.5.10.0 0.0.0.127 area 1 (config-router)network 10.5.10.128 0.0.0.127 area 1	R9 (config)#router ospf 5 (config-router)network 10.5.10.128 0.0.0.127 area 1

2.4. Check each router's routeing table.

Use the Inspect tool on each router (or the **show ip route** command at CLI).

Draw your conclusions.

We can see within the OSPF domain routeing tables are ok, all networks are reachable. OSPF ensures routeing information between areas.

Within the EIGRP autonomous system, routeing tables are ok, as well.

Issues are:

- In the OSPF domain, networks belonging to the EIGRP autonomous system are unknown.
- In the EIGRP autonomous system, networks belonging to the OSPF domain are unknown.
- A default route for the internet connection is missing.

3. Route redistribution

Autonomous System Boundary Routers (in our example R4 and R7) block routeing information propagation (as they are supposed to).

Nevertheless, ultimately, routeing has to work between networks even if they belong to different autonomous systems. We achieve this by inserting routeing information into the autonomous system routeing protocol, usually at boundary routers. This is called **route redistribution**.

In Cisco IOS we can configure this by using the redistribute command within the routeing protocol configuration level:

(config-router) **redistribute** {protocol-to-redistribute}

Where {protocol-to-redistribute} represents the routeing protocol (autonomous system) from which we want automatic copy of routeing information to the present autonomous system.

By default the redistribute command inserts only classful network addresses, to handle classless addresses, the **subnets** parameter must be added.

We can also insert static routeing information by using the **redistribute static** command. Local networks can also be inserted by using the **redistribute connected** command. For default route insertion, on the autonomous system boundary router that has the default route defined we can use the **default-information originate** command to insert it:

```
(config-router) default-information originate
```

One other issue we must handle is inserted information must have appropriate metric for the routeing protocol we are inserting into. Unless we are coping routeing information between same protocol autonomous systems, the metric value will have to be manually assigned.

4. Practical exercise - adding route redistribution

4.1. Define the default route and redistribute it

Router R7 is the autonomous system boundary router that provides internet connection to the ISP router, therefore, it's there we will insert the default route into OSPF area 0.

```
                    R7

(config)#ip route 0.0.0.0 0.0.0.0 190.0.0.2
(config)#router ospf 5
(config-router)# default-information originate
```

Check that, now, every OSPF domain router has a default route in the routeing table.

4.2. Redistribute OSPF domain information into the EIGRP autonomous system

This can be achieved at router R4 because it's the autonomous system boundary router that connects the EIGRP autonomous system to the OSPF autonomous system.

```
                    R4

(config)#router eigrp 100
(config-router)# redistribute ospf 5 metric 100000 100 255 1 1500
```

EIGRP metric is not available at OSPF domain, so we must define it manually using the metric parameter. The sample values above mean:

100000 (transmission rate in kbps) – 100 Mbps
100 (network delay in 10 microseconds units) – 1 millisecond
255 (reliability from 0 up to 255) – 100%
1 (network load from 1 up to 255) – 0 %
1500 (MTU value in bytes) – 1500 bytes

Check that, now, routers in the EIGRP autonomous systems know about networks inside the OSPF domain, including the default route inserted by R7 into the OSPF domain. However, the OSPF domain is still not aware of the EIGRP autonomous system networks. One additional step is required.

4.3. Redistribute static information into the OSPF domain

We could do as before for inserting EIGRP routeing information into the OSPF domain. We would enter into the OSPF configuration in router R4 and **redistribute eigrp 100**.

But we will use another approach: static information routes insertion:

```
                    R4

(config)#ip route 192.168.64.0 255.255.254.0 192.168.66.1
(config)#router ospf 100
(config-router)# redistribute static subnets
(config-router)# redistribute connected subnets
```

Now, networks 192.168.64.0/23 and 192.168.66.0/23 are known in the OSPF domain. The first, due to **redistribute static** command, and the second due to **redistribute connected** command.

Apart from the ISP router (outside our scope), every node is now able to communicate with any other node. Also, every packet sent to a destination address not belonging to aby managed network will be delivered to the ISP router.
