Networking lab – M2 MoSIG
Internal routing — OSPF

Martin Heusse

The topic of the lab is internal routing, within an autonomous system. They will also allow you to familiarize with actual routers (Cisco)

We use the OSPF routing protocol, which is the most popular internal routing protocol. We will also use it in the next lab about external routing.

1 OSPF

OSPF is the reference protocol for internal routing. It is a "link states" routing protocol. Every time the topology changes, it floods the network with a message containing the information about the topology change. This in turn allows each router to build a local representation of the topology, on which it computes the shortest path (using the Dijkstra algorithm) towards every destination (Hence the name: the routers use the shortest paths).

OSPF does not have the same shortcomings as RIP for instance. It converges just as fast when a link appears or disappears, there is no count to infinity problem. But OSPF is considerably more complex even for a simple network. One of the main reason for this complexity is the reliable flooding, and also the fact that OSPF allows two levels of hierarchy, which permits to use OSPF on networks of hundreds of routers.

1.1 OSPF hierarchy

OSPF allows to group the links within areas. All the link states in an area are not distributed to other areas. The should be at least an area 0 (backbone), to which all other areas are connected.

An ABR : *Area Border Router* has links in 2 different areas ; an ASBR : *AS Border Router* has links towards another AS (and probably uses BGP).

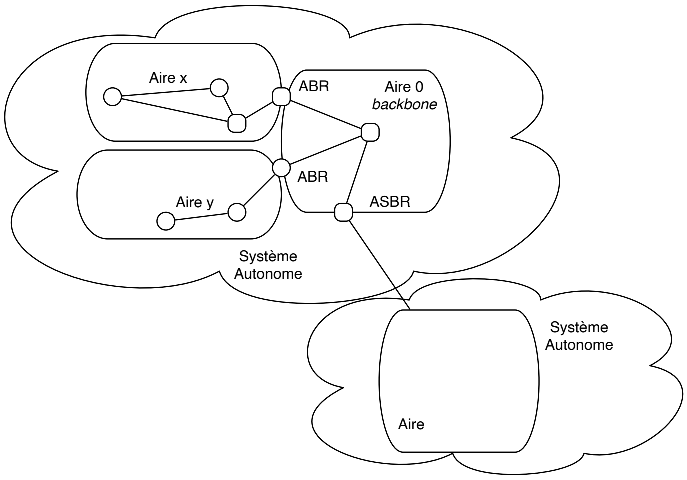

Figure 1: The different types of OSPF routers

2 Experiments

2.1 The routers

Routers are diskless machines that you configure using a serial line. Refer to the documentation to connect to the router.

It's better to start with an blank configuration on the routers. Issue `erase startup-config`: and restart the router: `reload`. (Do not enter the configuration dialog)

Quick guide to IOS commands :

- **at any time, type "?" to see the available commands;**
- **The tab key automatically completes the line or keyword;**
- **You to dot have to type the entire keywords :**
  ≪`sh ip o r`≫ is equivalent to ≪`show ip ospf route`≫;
- **You will generally start by typing `enable`, and then `configure terminal`...**
- **The commands are hierarchical, and more specific commands are available at each level. At any time, `list` gives you the available commands;**
- **`exit` (ou `^d`) exits the current command level and goes back to the previous one;**
- **`^z` goes back to the basic level (*configure*);**
- **Do not specify a password!**

Pick a network prefix that's unique to your group. E.g. 10.x.0.0/16 where x changes from one bench to the next.

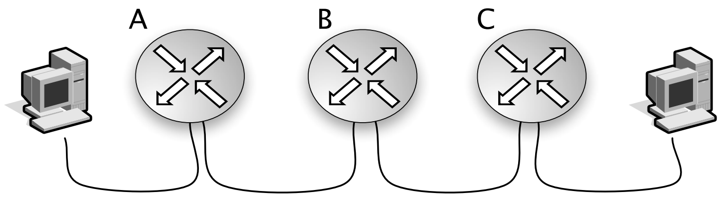

Figure 2: You network

Configure the router interfaces, after having decided of a proper addressing plan, within your chosen prefix.

Create static routes, and ping between S1 and B

`sh ip interface brief` gives you a summary of the status of the interfaces, it is more compact than e.g. `sh interfaces`.

The `write` command, in `enable` mode, saves the current configuration which is visible through `show running-config`. Note that one of the interesting features of IOS is that you can configure the router interactively and then once you are satisfied, save the current configuration. After entering `write`, check that `startup-config` contains what you expect.

2.2 OSPF

Remove the static routes and let's start using OSPF

2.2.1 *Backbone* area

The 3 routers above will be the backbone (area 0) or our OSPF network.

The `network` command above `router ospf` enables the use of OSPF on the corresponding interface, while specifying at the same time in which area it is. You specify a prefix (be careful, this is wildcard bits and not a mask!) and all the matching interfaces are then handled by OSPF.

Before you start OSPF, launch `wireshark` on at least one network (using hub, or port mirroring – see the doc.)

It may be of interest to restart OSPF on one router: `clear ip ospf id_process process`.

Do not forget to change the `hostname` (of the routers) and possibly the `router ID` to more intelligible values .

Once several interfaces are active and OSPF is running, comment the content of the captured packets. Note your operation on the various machines and their effects

What are we supposed to observe? *Many things! HELLO packets ; Database description exchanges when two routers discover each other on a link ; LSA coming from other parts of the network. . .*

`show ip ospf interface` gives you the status of the different interfaces handled by OSPF. How were the *Designated Router* elected ? What is their purpose?

Comment the output of `show ip ospf database` and `show ip ospf database {router|network} linkID` for each `linkID` in the database. See how you can build a map of the network from these commands.

Look at the output of `show ip ospf route`, and check that is matches the OSPF *database* .

Remark : The routes are prefixed by (`N` for *network* for example), as well as by their origin (`IA` for *inter-area,* or `E` for a protocol different of OSPF)

2.2.2 A second area

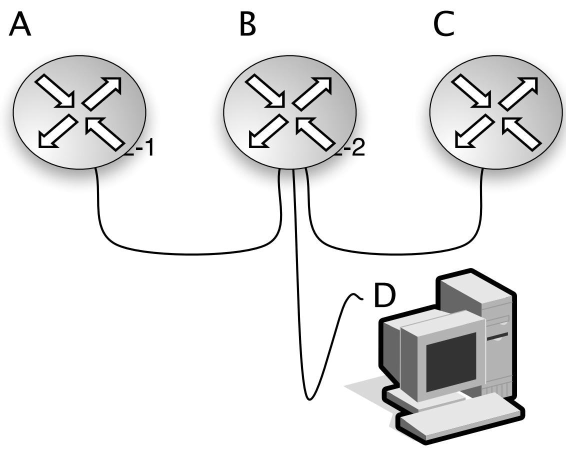

Figure 3: Second area

We add a fourth router, and put this link in a different OSPF area. (this router will use quagga.)

To make things a bit more interesting, activate a second link on D, possibly by adding a public prefix to the loopback interface.

Capture all the routing traffic again. Check the OSPF database to follow what happens. You can always de-activate an interface using shutdown to create temporary topology changes.

What do you observe? What is the purpose and effect of having different areas?

Activate OSPF on the other interface of D.

OSPF allows to group prefixes together. (command `area` *`num_aire`* `range` *`a.b.c.d m1.m2.m3.m4`* on top of `router ospf`.)

Can you propose an addressing plan in this *stub* area and a configuration of B which leads to such an aggregation?

2.2.3 Joint use of two routing protocols : RIP and OSPF

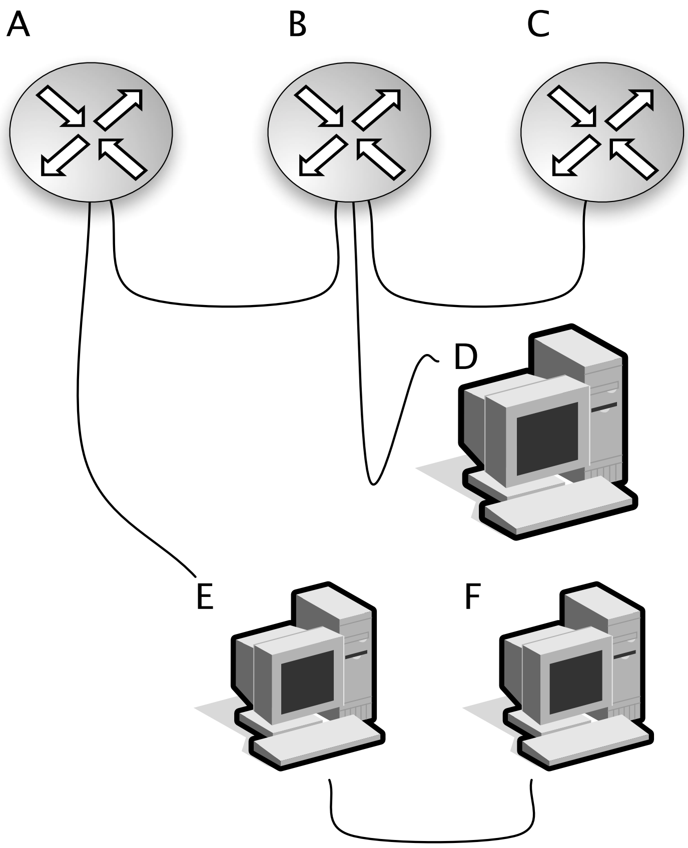

Figure 4: Using RIP between the routers E, F and A

We add a 5th and 6th machine to the network (figure 4), both running `routed`. (We recommend to use ≪`-s -P ripv2 -i`≫ – Why ?) On A, you have to activate RIP (router rip / network... – Beware, you also need to specify to use `version 2` on A, under `router rip`)(Note that on the machines running routed, `-i` allows to use `rtquery`). We want all routes from both networks to be shared, so you need to distribute the RIP routes into OSPF and vice versa.

Do not forget:

- activate routing on the FreeBSD machines `sysctl net.inet.ip.forwarding=1` and
- add the following route if `routed` does not start :
  `# route add 224.0.0.0/4 127.0.0.1`

The `redistribute` keyword allows the passing of information between routing protocols on the router. How and where is the information found and used?

You can use the `rtquery` tool to query the routing database of `routed`. Note also how the routes appear in the OSPF database.

This type of interaction between routing protocol is fundamental to the coexistence of internal and external routing, which is the subject of the next lab sessions.

1st advice : When redistributing OSPF routes into RIP, make sur to define the metric associated with the created routes, e.g.:
`# redistribute ospf 1 metric 1`

2d advice : When redistributing RIP routes into OSPF, you could start with a simple `redistribute rip` command. But in this case only class A, B or C routes would be redistributed. If you want subnets of any size to be redistributed, add the `subnets` keyword:
`#redistribute rip subnets.`

Save the configuration files, which will be useful for the BGP lab.

Now add the *stub* attribute to the area of B and D. (This must be done on all routers of the area.)

What's the point? (Find what happened.)

2.2.4 Observation of the designated router mechanism

We want to see the *designated router* in action on a broadcast network. We add **station C to network 1**, and we make sure it becomes designated router. We thus have the network in Figure 5.

The most straightforward way of having C become the designated router is to give it a higher priority, switch off the network and turn it back on again.

Start `wireshark` and make a change to the topology somewhere else. Observe the traffic. Pay special attention to the source and destination addresses of the exchanged packets.

2.2.5 General interconnection!

Connect you network to the one of you neighbors… *Etc.* Let's see if OSPF scales to 50 routers!

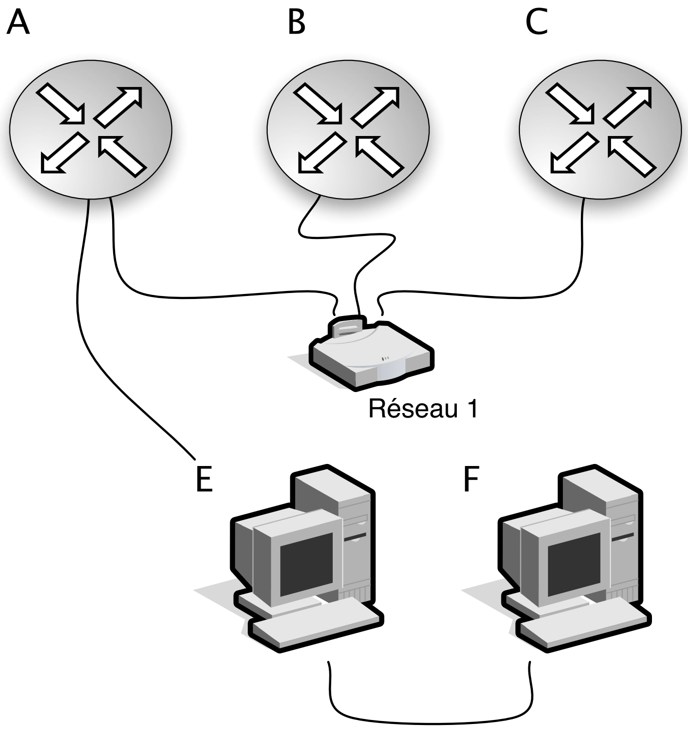

Figure 5: Designated router and backup designated router : B and C