Lab 1.5. RIP and BGP

Objectives

In this lab, we will establish elementary concepts of IP routing. In particular, we will study one interior and one exterior routing protocol: RIP (*Routing Information Protocol*) and BGP (*Border Gateway Protocol*).

There are several implementations of the routing protocols. In this lab, we are going to use Quagga, which currently implements RIP (versions 1 and 2), RIPng, OSPF (versions 2 and 3), IS-IS and BGP. Quagga is structured in several services (one per each protocol) controlled by a central service, `zebra`, which serves as an interface between the kernel routing table and the routing information of each protocol.

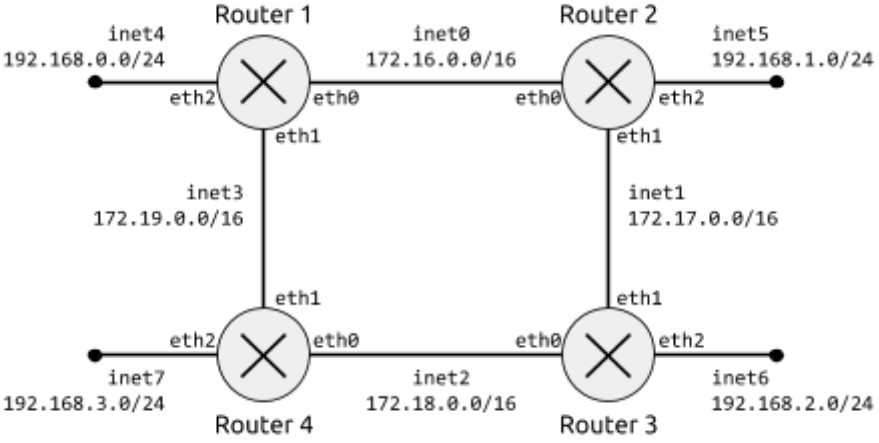
All the configuration files must be stored in directory `/etc/quagga`. The syntax of these files is simple and is available in http://quagga.net. Review the syntax of RIP and BGP in http://www.nongnu.org/quagga/docs/docs-info.html.

Contents

Part I. Interior Protocol: RIP

Environment Preparation

We will deploy the network topology shown in the following figure:



Each router has three interfaces, each of them connected to a different internal network.

As in previous labs, we will use the `vtopol` tool to automatically build this topology. The topology configuration file has the following content:

```
netprefix inet
machine 1 0 0 1 3 2 4
machine 2 0 0 1 1 2 5
machine 3 0 2 1 1 2 6
machine 4 0 2 1 3 2 7
```

To ease the configuration of VMs, the following table shows the addresses of each router's interface:

VM	Interface	Internal network	Network address	IP address
Router1	eth0 eth1 eth2	inet0 inet1 inet2	172.16.0.0/16 172.19.0.0/16 192.168.0.0/24	172.16.0.1 172.19.0.1 192.168.0.1
Router2	eth0 eth1 eth2	inet0 inet1 inet5	172.16.0.0/16 172.17.0.0/16 192.168.1.0/24	172.16.0.2 172.17.0.2 192.168.1.2
Router3	eth0 eth1 eth2	inet2 inet1 inet6	172.18.0.0/16 172.17.0.0/16 192.168.2.0/24	172.18.0.3 172.17.0.3 192.168.2.3
Router4	eth0 eth1 eth2	inet2 inet3 inet7	172.18.0.0/16 172.19.0.0/16 192.168.3.0/24	172.18.0.4 172.19.0.4 192.168.3.4

RIP Configuration

Exercise 1. Configure all routers according to the previous figure. Check that:

- Adjacent routers are reachable, for example, Router1 can ping Router2 and Router4.
- The routing table of each router is correct and includes an entry for each connected network.

Also, enable IPv4 packet forwarding as in Lab 1.1.

Exercise 2. Configure RIP in all routers to exchange routing information:

- Create a `ripd.conf` file in `/etc/quagga` with the content shown below.
- Restart the RIP (and zebra) service with `service ripd restart`.

Content of file `/etc/quagga/ripd.conf`:

```
# Activate RIP routing
router rip
# Define protocol version
version 2
# Enable routing information on networks associated to the interfaces
network eth0
network eth1
network eth2
```

Note: There are sample files for Quagga configuration in `/usr/share/doc/quagga/examples`.

Exercise 3. Check the routing table of RIP and `zebra` of each router with the `vtysh` command. Check also the kernel routing table with the `ip` command.

```
# vtysh -c "show ip rip"
...
```

```
# vtysh -c "show ip route"
...
# ip route
...
```

Exercise 4. Analyze RIP messages with `wireshark`. In particular, check:

- Message encapsulation.
- Source and destination addresses.
- Version field.
- Information for each route: Network address, Subnet mask, Next-hop address and Distance.

Exercise 5. Remove the link between Router1 and Router4 (e.g. disabling interface `eth1` in Router4). Check that Router1 stops receiving announcements from Router4 and that, after about 3 minutes (the default timeout value for route expiration), its routing table has been readjusted.

Exercise 6 (Opcional). Quagga services can be configured in an interactive way through a terminal (`telnet`), in a similar way as commercial routers. To enable the virtual terminal (VTY), add the command `password` to the configuration file of the desired service. Then, configure `ripd` via VTY:

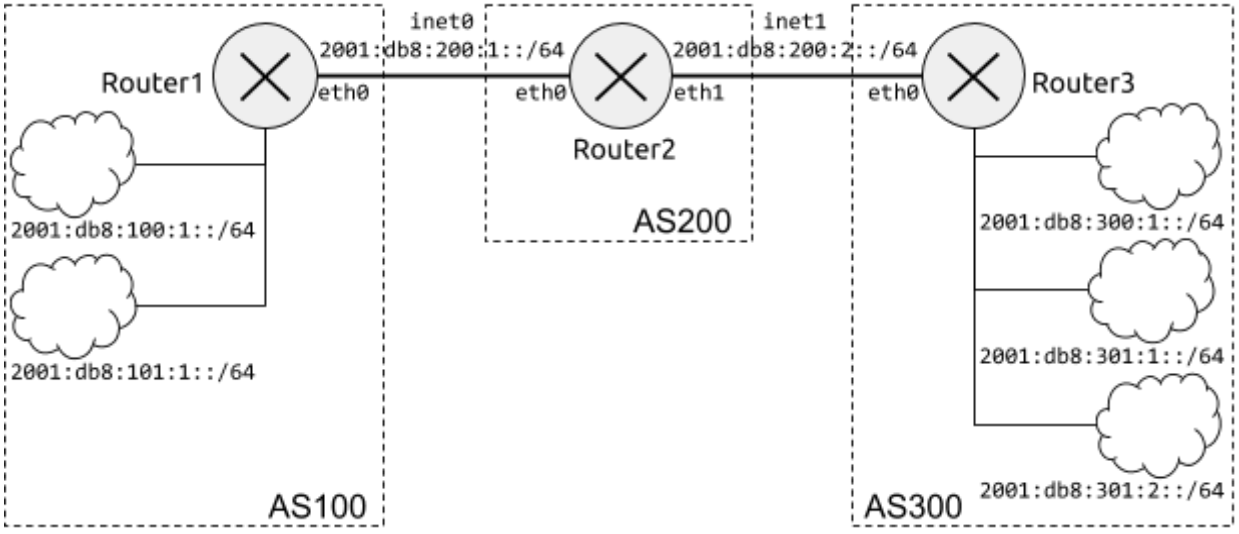
- Add "`password redes`" to file `ripd.conf`, disable the protocol ("`no router rip`") and comment out all the other entries. After that, restart the service.
- Connect to the VTY of the RIP service and configure it. For each command, '`?`' can be typed to show the associated help.

```
# telnet localhost ripd
Trying 127.0.0.1...
Connected to ip6-localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.20.1)
Copyright © 1996-2005 Kunihiro Ishiguro, et al.
User Access Verification

Password: redes
localhost.localdomain> enable
localhost.localdomain# configure terminal
localhost.localdomain(config)# router rip
localhost.localdomain(config-router)# version 2
localhost.localdomain(config-router)# network eth0
localhost.localdomain(config-router)# write
Configuration saved to /etc/quagga/ripd.conf
localhost.localdomain(config-router)# exit
localhost.localdomain(config)# exit
localhost.localdomain# show running-config
Current configuration:
!
password redes
!
router rip
  version 2
  network eth0
!
line vty
!
end
localhost.localdomain# write
Configuration saved to /etc/quagga/ripd.conf
localhost.localdomain# exit
```

Part II. Exterior Protocol: BGP

Environment Preparation

We will deploy a network topology with 3 ASes, where one of them is the provider of the other two:



Note: The prefix `2001:db8::/32` is reserved for documentation and examples (RFC 3849).

We will create this topology (without the internal networks) with the `vtopol` tool and the following file:

```
netprefix inet
machine 1 0 0
machine 2 0 0 1 1
machine 3 0 1
```

The following table shows the addresses of each interface of the routers:

VM	Interface	Internal network	Network address	IP address
Router1	eth0	inet0	2001:db8:200:1::/64	2001:db8:200:1::1
Router2	eth0 eth1	inet0 inet1	2001:db8:200:1::/64 2001:db8:200:2::/64	2001:db8:200:1::2 2001:db8:200:2::2
Router3	eth0	inet1	2001:db8:200:2::/64	2001:db8:200:2::3

Exercise 1. Determine the AS type and the network prefixes that should be advertised, taking into account that the RIR assigned each AS prefixes of 48-bit length and that prefixes must be aggregated.

AS Number	AS Type	Announced networks

Exercise 2. Configure all routers according to the previous figure. Check connectivity between adjacent VMs.

BGP Configuration

Exercise 1. Configure BGP on routers to exchange routing information. To do this:

- Create a `bgpd.conf` file in `/etc/quagga`, using the file provided below as a reference.
- Start the BGP (and zebra) service with `service bgpd start`.

Content of file `/etc/quagga/bgpd.conf` of Router1 in AS100:

```
# Activate BGP routing on AS100
router bgp 100
 # Set the BGP router ID
 bgp router-id 0.0.0.1
 # Add the BGP neighbor router in AS200
 neighbor 2001:db8:200:1::2 remote-as 200
 # Start working with IPv6 addresses
 address-family ipv6
  # Advertise an aggregated network prefix
  network 2001:db8:100::/47
  # Activate IPv6 in the BGP neighbor router
  neighbor 2001:db8:200:1::2 activate
 # Stop working with IPv6 addresses
 exit-address-family
```

Exercise 2. Analyze with `wireshark` the BGP messages (OPEN, KEEPALIVE and UPDATE) exchanged.

Exercise 3. Using the `vtysh` command, check the routing table of BGP and `zebra` on each router. Check also the kernel routing table with the `ip` command.

```
# vtysh -c "show ipv6 bgp"
...
# vtysh -c "show ipv6 route"
...
# ip -6 route
...
```