

Universidad Carlos III de Madrid  
Department of Telematic Engineering

# Computer Networks

Lab: Routing

Bachelor in Informatics Engineering

## 1. Objective

The main objectives of this lab is to become familiar with the work environment (GNU /Linux) and routers to be used in the course (Linksys WRT54GS). Once familiarized with them, you must configure an IP network whose connectivity is initially achieved by assigning static routes and then enabling the RIP routing protocol. For this second part we will start from a scenario whose address structure has already been studied and planned beforehand.

For this lab, students will work on setting up a simple scenario consisting of two terminal devices (PCs), two routers Linksys WRT54GS and then two additional router (forming a network with 4 routers Linksys).

In the sections corresponding to the IP network configuration, first you must have the addresses and static routes on both routers and the PCs that connect to the routers. Later, we employed a dynamic routing protocol (RIP) on routers.

Each PC has the TCP/IP stack available which enables the communication through the network interface. In order to get information about the TCP/IP stack implementation, we recommend to use the manual pages (e.g. `man 7 ip`).

## 2. Laboratory details

Carefully read the laboratory text completely before starting.

The laboratory evaluation is performed with a **document elaboration**. **This document must be delivered no later than a week after the fourth lab session, by means of an Aula Global submission entry**. This Lab is organized as a series of milestones that must be completed. **Once you are sure you have completed a milestone, take some screenshots justifying the accomplishment of that milestone and explain very briefly in a document the justification (you only have to explain the test that clearly demonstrate that the milestone has been achieved)**. If you have problems with a milestone please contact the teacher.

**It is mandatory to download and install the Virtual Machine BEFORE THE LAB SESSIONS (check the instructions in Aula Global).**

Please consult the Linksys WRT54GS router manual available at [http://www.it.uc3m.es/fvalera/ro/Linksys\\_routers\\_manual\\_uc3m\\_English.pdf](http://www.it.uc3m.es/fvalera/ro/Linksys_routers_manual_uc3m_English.pdf) (you may alternatively get it from the labs section in Aula Global).

### Milestone XX

**The parts of the statement in this format show the milestones of the laboratory.  
Please fill a document section with each of these (brief section)**

### 3. RySCA -2021 (Lightning) Virtual Machine Setup

1. Follow the installation instructions (available in Aula Global).
2. Open VirtualBox and launch the “RySCA - 2021” Virtual Machine.
3. Open a Terminal and introduce **TWICE** the following command:

`lightning update`

4. Once the lightning has been correctly updated it is time to set up the laboratory scenario. To do so, write the following command in the Terminal window (depending on the Part you are doing you will have to load the first scenario or the second one):

a. Part I (section 4)      `“lightning start RSC/S16_escenario_1”`

b. Part II (section 5)      `“lightning start RYSCA/p_encam_a”`

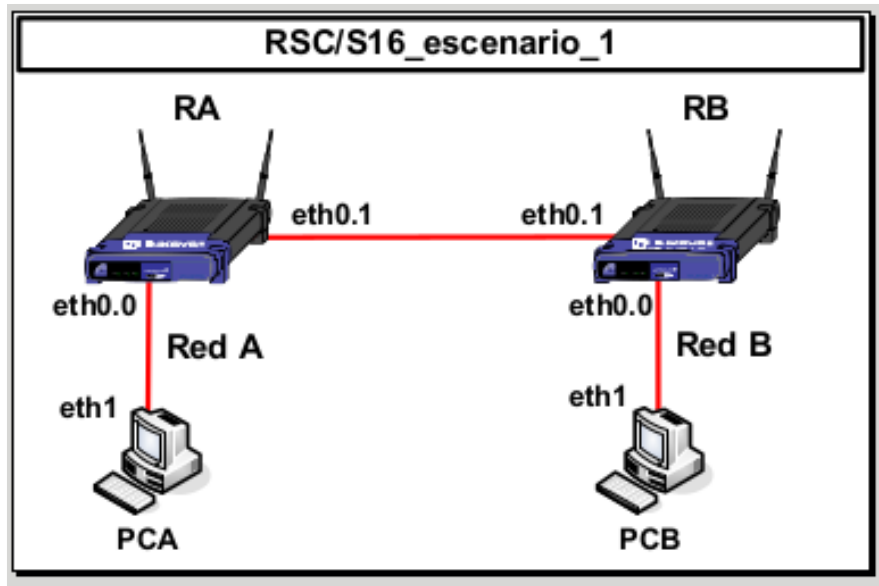
5. Wait until the whole setup is done.
6. You will see a figure with configured topology and in addition to this figure a several terminals are opened, each of them corresponding to a particular router or host.
7. Now you are ready to work with the topology as if you had it set up in the laboratory with the physical equipment (PCs and Linksys WRT54GS routers), using the same configuration commands that are used in them.
8. If you want to stop the created scenario just execute the following command:

`lightning stop`

9. If you don’t want to lose your work progress when you leave, please do not power off the virtual machine, just click on the “Save the machine state” button when closing the VM window.

## 4. Part I: Simple network interconnection

The proposed work includes the set up and the configuration of a simple network scenario depicted in figure 1. Once the required network is configured, the next step is to check that it is properly working.



### 4.1. Part I – Steps to follow

1. Start the VM and load the scenario by typing "**lightning start RSC/S16\_escenario\_1**".
  - a. Assign an IP address to the Ethernet interface of computer PCA that is tagged as **eth1** and that is connected to Network A (the address must belong to the 10.0.A.0/24 prefix, A being any valid number that you arbitrarily select). There are several options to assign an IP address to a network interface in Linux. The most commonly used is the **ifconfig** command, but currently its usage is **NOT** recommended and the **ip** command is preferred instead because it is easier to use and more flexible. The **ip** command has a useful help manual, you are just required to type '**ip help**', or: '**man ip**').
  - b. Assign an IP address to the interface of router A that is connected to the Network A (this IP address must belong to the prefix assigned to Network A, i.e. 10.0.A.0/24). Check the router's manual to see how to configure IP addresses in the router interface.
  - c. Verify that the router and the host can reach each other using the **ping** command (either from the PC and/or the router).

2. “Connect” routers A and B through their Ethernet interfaces.
  - a. Assign IP addresses to the interfaces that connect both routers. These IP addresses must belong to the 10.0.0.0/30 prefix.
  - b. Verify that routers can reach each other using the **ping** command.
  - c. Assign an IP address to the interface of router B connected to Network B (this address must belong to the prefix assigned to the Network B i.e. 10.0.B.0/24 for any valid value of B, different than A).
  - d. Configure in both routers the routing table entries so that router A can reach network B and vice versa. Check the manual of the router to find out how to configure static routes in the router.
  - e. Configure the routing tables in the host in network A (PCA) so it can reach network B. To configure the IP routing table of a Linux PC (and in general any UNIX machine), we have several options. The most classic is to use the **route** command, but - as with setting directions - now recommended not to use this command, in favor of the **ip** command.
  - f. Perform the corresponding settings in PCB (IP address, routing table) so that it is included in the network configuration.
  - g. Use the **ping** command from PCA to PCB.
  - h. Determine the route used by packets using the **traceroute** command (you can use the ‘-n’ modifier to allow a faster execution of the command).

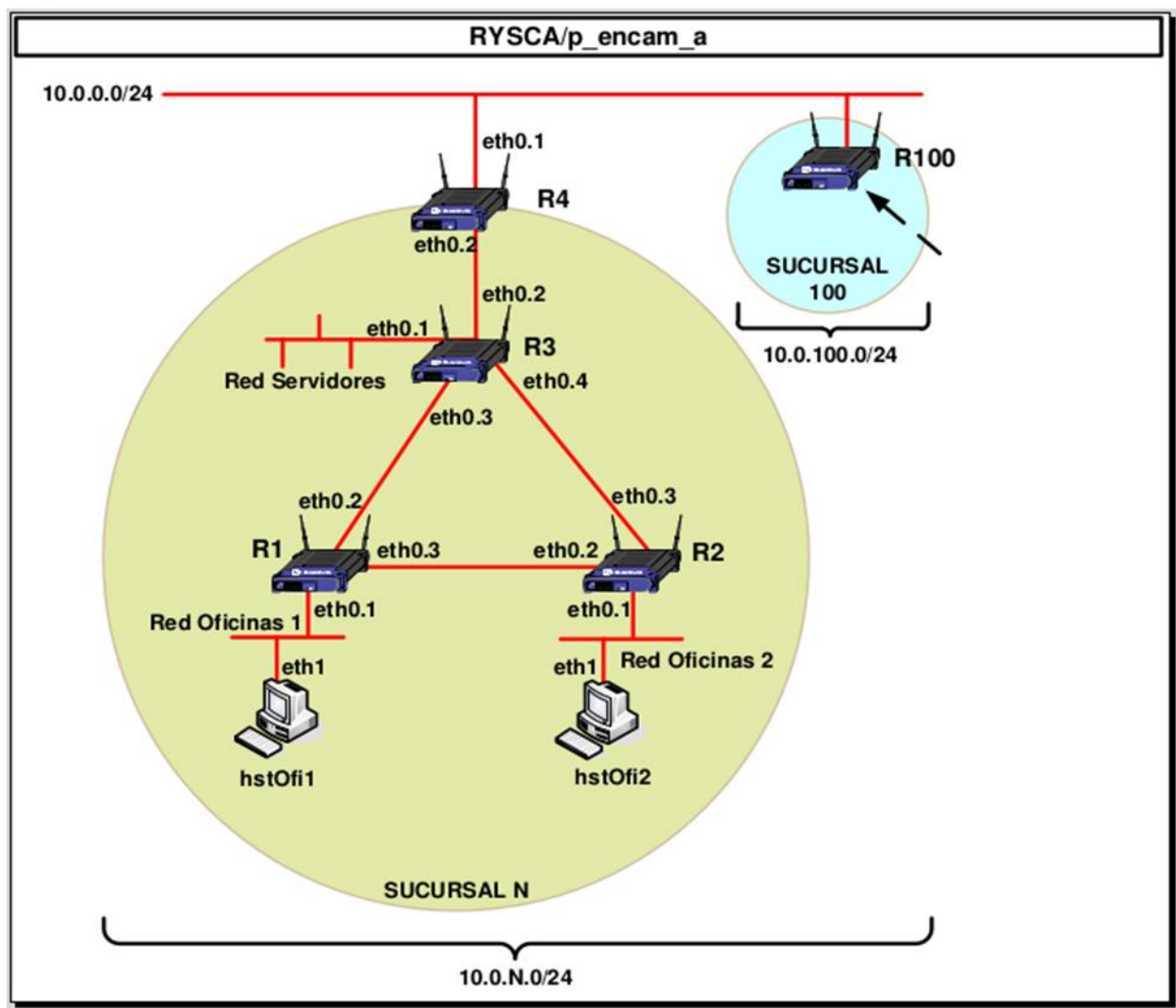
**Milestone 1 (2 points)**

Check the connectivity between the network A and B using the **ping** and **traceroute** commands from PCA to PCB. Once the required configuration has been done, and the functionality checked, fill a section in your document with this milestone including screenshots of the ping and traceroute and a short explanation

## 5. Part II: Network configuration

This section is intended to build and configure the IP network corresponding to the one specified in addressing exercise. The logical architecture of the scenario is shown in Figure 2.

This scenario corresponds to the network topology of a particular branch. Assign addresses to the network based on the results of addressing exercise.



The design requirements for Figure 2 scenario are as follows:

- The address range available for the branch is 10.0.X.0/24, where 'X' indicates the last two digit numbers of the NIA of any of the group
- The core network interconnecting all branches has the address range 10.0.0.0/24.
- Linksys WRT54GS routers will be used, each with 5 LAN (Ethernet) interfaces.
- Each branch has several areas, namely Office 1, Office 2 and a Server room. Because of the nature of the work performed in each area, independent networks are required, and are interconnected as shown in the diagram of Figure 2. This scheme provides a certain redundancy against link failures. Take this redundancy into consideration when designing the routing tables required in the routers.
- The network of Office 1 must have capacity to allow the connection of up to 100 hosts (PCs, printers, etc.).
- The network of Office 2 must have capacity allow the connection of up to 25 hosts (PCs, printers, etc.).
- The Servers network must have capacity to allow the connection of up to 10 hosts.
- Addresses must also be assigned to the different point-to-point networks used to interconnect the routers.

## 5.1. Part II – Steps to follow

The steps to carry out the practice are the following:

1. Start the VM and load the scenario by typing "**lightning start RYSCA/p\_encam\_a**".
2. Assign IP addresses to the router interfaces (R1, R2 and R3) and to the hosts (hstOfi1 and hstOfi2) and check that connectivity exists between PCs hstOfi1, hstOfi2 and the routers R1, R2, respectively, using, for example the **ping** command.
3. Assign IP addresses to each of the point-to-point network that interconnects the routers R1, R2 and R3 and check connectivity.
4. Configure the required static routes in R1, R2, R3 and in the PCs connected to the different networks to ensure total connectivity between all subnets. Check that connectivity exists between the different subnets using, for example, the ping command. Check also that the route taken by the packets is the right one, using the **traceroute** command (from the routers as well as from the PCs).
5. "Connect" R4 and configure the necessary routes in all pieces of equipment to ensure connectivity of the global scenario.
6. Configure in the routers the additionally required backup routes, in such a way that if a link is broken between R1, R2 y R3, global connectivity is not lost. To force a link failure, use the interface configuration command **shutdown** to disable the interfaces of each one of the two routers connected to the link (if you have doubts about this point, consult with the lab teacher).

#### Milestone 2 (5 points)

Check that from any router and PC you have IP connectivity with any network interface of all pieces of equipment of the scenario (and that the route taken by the packets is the best possible). Check that global connectivity is maintained, even in the event of a link failure between R1, R2 y R3 (you may for instance traceroute from hstOfi1 to R4, shutdown one of the routers link used in this path and traceroute again to verify that the alternative route is taken). Once the required configuration has been done, and the functionality checked, fill a document section with this milestone.

7. Remove the static routes previously configured in the routers (maybe reloading the scenario is faster). Now the RIP routing protocol will be used.
8. Enable and configure the dynamic routing protocol RIP in the corresponding router interfaces. Verify, using the router's visualization commands, that the RIP protocol is working correctly.

#### Milestone 3 (1.5 points)

Check that from any router and PC you have IP connectivity with any network interface of all pieces of equipment of the scenario (and that the route taken by the packets is the best possible). Verify, using the router's visualization commands, that the RIP protocol is working correctly. Once the required configuration has been done, and the functionality checked, fill a section of the document to be delivered with this milestone (some screenshots with the pings and traceroutes and some sentences of explanation).

9. Disconnect the wire interconnecting routers R1 and R2 (using **shutdown** command).

#### Milestone 4 (1.5 points)

Verify that after some time, the routing protocol restores a path between the two office subnets. Verify that with the link between R1-R2 down – and once the convergence time has elapsed (knowing that the routers used are not capable of detecting the failure/recovery of a link when it happens) – from any router and PC you have IP connectivity with any network interface of all pieces of equipment of the scenario (and that the route followed by the packets is the best possible). Verify, using the router's visualization commands, that the RIP protocol is working correctly. Once the required configuration has been done, and the functionality checked, fill a final section in your document with this milestone (some screenshots with the pings and traceroutes and some sentences of explanation).

## 6. References

- [1] GNU/Linux manual (**man <command>**)
- [2] Linksys WRT54GS router configuration manual, <http://www.it.uc3m.es/linksys/english>
- [3] Linux Advanced Routing & Traffic Control HOWTO, <http://www.lartc.org/howto>
- [4] Linux Networking HOWTO, <http://www.tldp.org/HOWTO/Net-HOWTO/>