

Universidad Carlos III de Madrid
Department of Telematic Engineering

Computer Networks

Practice: Routing

Bachelor in Informatics Engineering

1. Objective

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

For these practices, students will work on setting up a simple scenario consisting of a terminal device (PC), 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 Norms

Read the laboratory text fully and carefully before starting.

The laboratory evaluation is performed during the laboratory session. It is done by a series of milestones that must be completed. Inform the laboratory teacher when you complete the required configuration and have checked that the scenario fulfills the required functionality at each milestone.

In order to do the laboratory it is necessary to have a Telematics Engineering Department teaching lab user account. For some of the commands it is necessary to have *superuser* (administrator) privileges. For those commands (address configuration, route configuration, etc.) you should place in front of the command the word *sudo* (your user password will be required). If you have problems, ask the lab teacher.

Please consult the Linksys WRT54GS router manual available at <http://www.it.uc3m.es/linksys/english>

Milestone XX

**The parts of the statement in this format show the milestones of the laboratory.
Please let the lab teacher know when you complete each and every one of them.**

3. 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 if it is working properly.

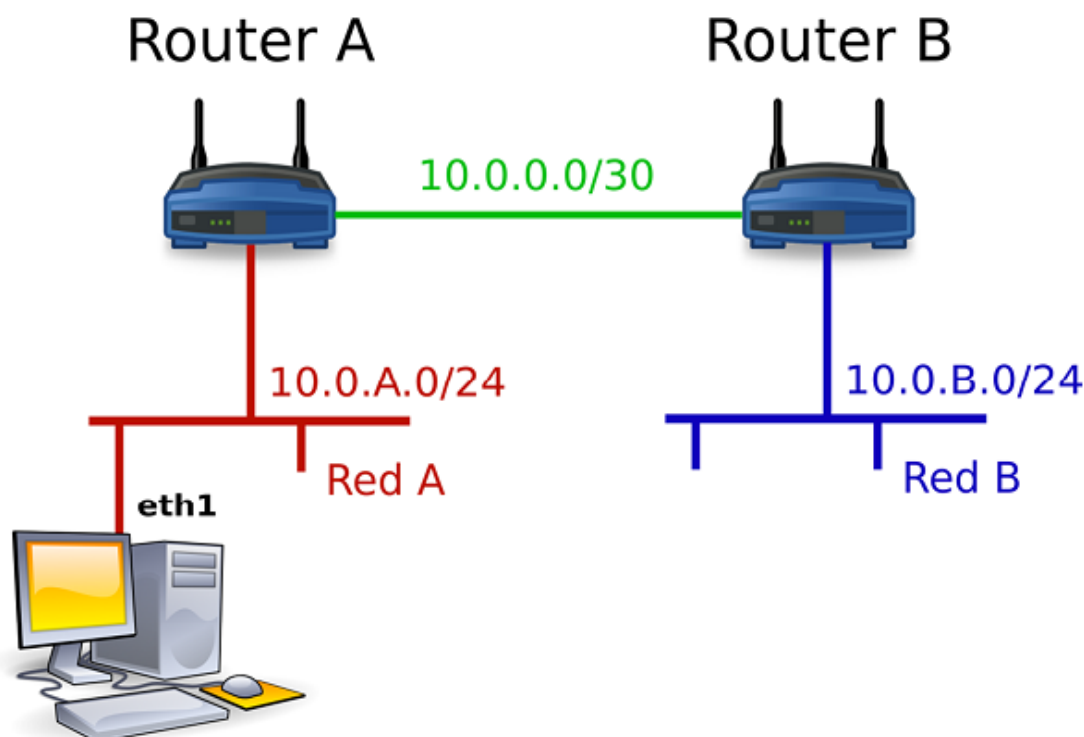


Figura 1 - Diagrama de interconexión (parte I)

3.1. Part I – Steps to follow

1. Connect one interface of router A with the PC interface tagged as Prácticas1 (**eth1**) using a hub. Each computer lab has at least 2 Ethernet cards. Typically, the topmost is the one that provides public Internet connection (called eth0). **Do not use in the practice eth0. Eth1 interface (labeled Eth-Pract) is to be used in practice.**
 - a. Assign an IP address to the Ethernet interface of the computer that is tagged as Prácticas (**eth1**) and that is connected to the 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 configure an IP address to a network interface in Linux. The most commonly used is the **ifconfig** command, but currently its usage is not recommended but to use the **ip** command 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 (such IP address must belong to the prefix assigned to Network A, i.e. 10.0.A.0/24). Look up in the router's manual 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 of the router used to connect to each other. These IP addresses must belong to the 10.0.0.0/30 prefix.
 - b. Verify that the routers can reach each other using the **ping** command on each router.
 - 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 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. Use the **ping** command from the host connected to network A to the interface of router B connected to network B.
 - g. Determine the route used by packets using the **traceroute** command.

Milestone 1

Check the connectivity between the network A and B using the ping and traceroute commands from the host connected to network A to the interface of router B connected to network B.

NOTE

This first milestone is expected to be completed after the first lab session with some support from the teacher. For the rest of the practice, this support will be reduced and you will have to work with your team mate and improve your ability to search information. You will also have the CORE software to help you. The teacher will of course be available for you to solve any theoretical doubts you may have, but no practical doubts will be solved in class.

4. Part II –Network configuration

This section is to build and configure the IP network corresponding to the specified in routing 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.

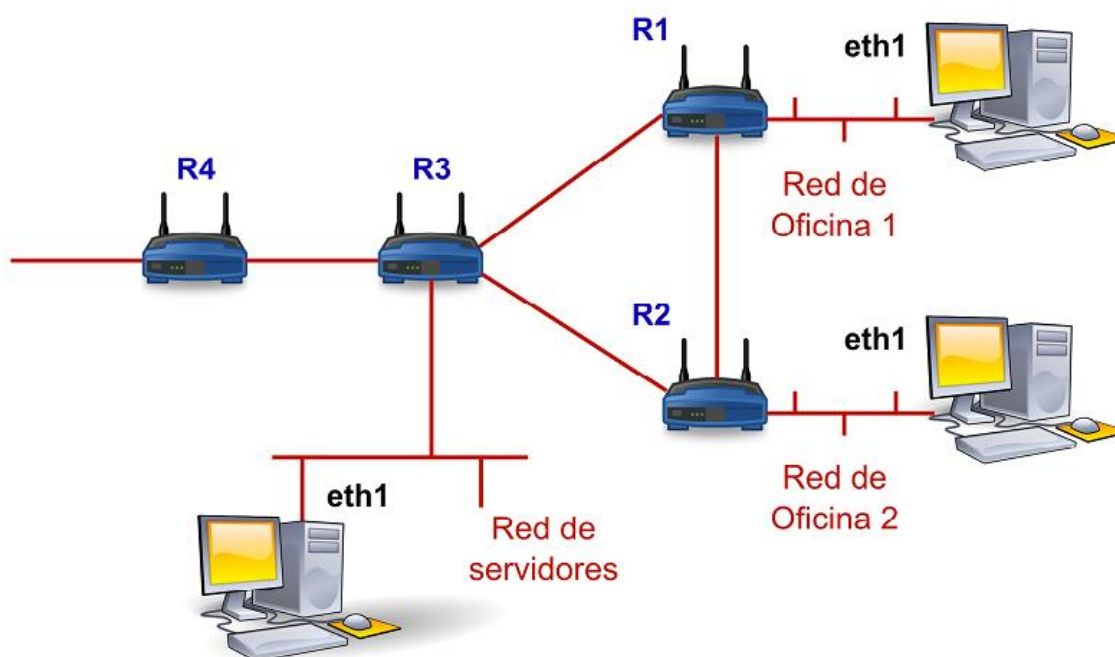


Figura 2 – Diagrama de interconexión (parte II)

The design requirements for the 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 service up to 100 connected pieces of equipment (PCs, printers, etc.).

- The network of Office 2 must have capacity to service up to 25 connected pieces of equipment (PCs, printers, etc.).
- The Servers network must have capacity to service up to 10 connected pieces of equipment.
- Addresses must also be assigned to the different point-to-point networks used to interconnect the routers.

4.1. Part II – Steps to follow

The steps to carry out the practice are the following:

1. Build the Office 1, Office 2 and Server networks. For each network, use a hub/switch to connect the PC's practice interface (**eth1**) to one of the Linksys router interfaces (R1, R2 o R3). Assign an IP addresses to the router interface and another to the PC practice interface. Check that connectivity exists between the PC and the router using, for example the **ping** command.
2. Interconnect routers R1, R2 and R3 as indicated in the figure. Assign IP addresses to each of the newly created point-to-point network that interconnects the routers.
3. Configure the required static routes in R1, R2, R3 and in the PCs connected to the different networks to insure 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).
4. Connect R4 and configure the necessary routes in all pieces of equipment to insure connectivity of the global scenario.
5. 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 simulate a link failure, use the interface configuration command **shutdown** to disable the interfaces of each of the two routers connected to the link (if you have doubts on this point, consult with the lab teacher).

Milestone 2

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. Once the required configuration has been done, and the functionality checked, call the lab teacher to verify this milestone.

6. Remove the static routes previously configured in the routers. Now the RIP routing protocol will be used.
7. 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

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, call the lab teacher to verify this milestone.

8. Disconnect the cable interconnecting routers R1 and R2.

Milestone 4

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, call the lab teacher to verify this milestone.

5. 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/>