TÉCNICO LISBOA

INTEGRATED MASTER (MSC) IN ELECTRICAL AND COMPUTER ENGINEERING

NETWORKS AND INTERNET SERVICES

Laboratory Assignment

Internet Access

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1. Objective

This laboratory assignment has the objective of studying Internet Access: configuration, testing, performance and quality of service (QoS). The familiarization with the Cisco IOS environment is also an objective.

The report should be done with the answers to the questions and the results requested in this assignment. It should be submitted into the Fenix system in PDF format until 23h59m of the Saturday following the last class scheduled for the work. During the class, it may be helpful to take printscreens to answer the questions.

2. Architecture

The architecture to be implemented is shown in figure 1. The Cisco router should be connected to an outside Internet access port. A PC should be connected to the router, accessing the Internet through it. This is a configuration very similar to a small office or home office Internet access.

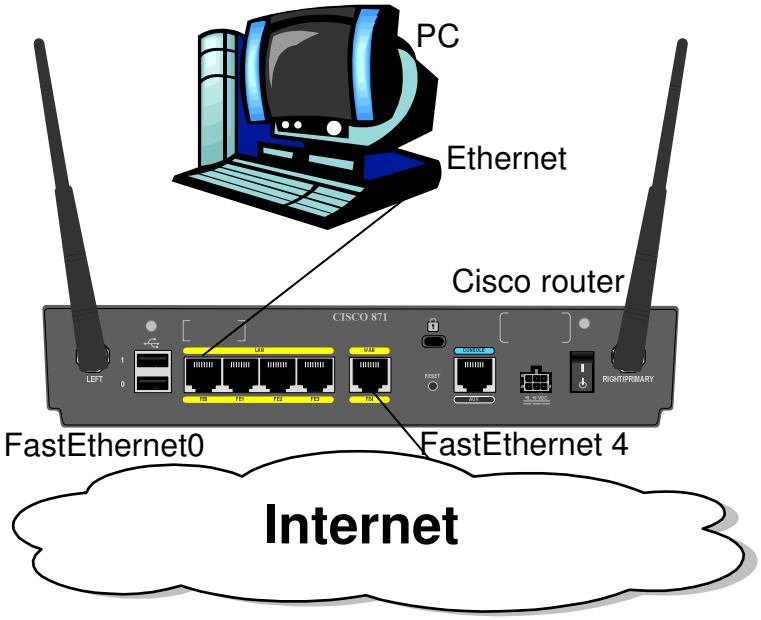

Figure 1: Network Architecture.

For this assignment, you are recommended to use the laboratory PC under the **Linux** operating system. table 1 shows some useful commands at the Microsoft Windows Command prompt or at a Linux Terminal.

Table 1. Some useful commands.

Objective	**Windows command prompt**	**Linux Terminal**
Check IP/MAC addresses	ipconfig /all	ifconfig
Check default route address	ipconfig /all	route -n
Check name server	ipconfig /all	cat /run/systemd/resolve/resolv.conf
Check host	ping *host*	ping *host*
Find network path	tracert *host*	traceroute *host*
Start an SSH session	putty *user@host*	ssh *user@host*

3. Router Basic Configuration

a) Connect the router according to Figure 1.

b) The Cisco router is pre-configured with an IP address in the network 10.10.10.0/29 and a Dynamic Host Configuration Protocol (DHCP) server. The DHCP protocol allows a DHCP server to assign IP addresses to clients that ask for them. In the PC, get an IP address from the Cisco router through DHCP. This is automatically done when the cables are connected, but may take a few seconds. Verify the network configuration in a terminal. The network configuration of the PC should be set to obtain an IPv4 address automatically (DHCP). What IP address did you get for your PC? What is the MAC address of the PC's Ethernet card (which appears as ether address under Linux or Physical Address under Windows)? What is the IP address of the router used (which appears as the Gateway)?

c) Current browsers do not support Java, required for having access to the router web interface (Cisco Configuration Professional (CP) Express). So, you will have to use the Cisco IOS (Internetwork Operating System) command line interface for all configurations. You can access it by logging in into the router using the Secure Shell (SSH) protocol. This can be done through the ssh command under Linux or the "PuTTY" [1] application under Windows. Provide the router IP address you got in b) for the hostname. Provide also the login data (username/password). Never save your configuration in non-volatile memory with the "write" or "copy running-configuration startup-configuration" commands.

d) Configure a static address and network mask for the interface FastEthernet4 (WAN), according to the table you were working on, according to the following laboratory map. Activate the interface. The commands required are given (the part before "#" is the router prompt). You must substitute "dd" by the required address. Which IP address was used for the WAN?

```
yourname#configure terminal                                  enter configuration mode
                                                             reading commands from terminal
yourname(config)#interface fastEthernet 4                    enter interface 4 configuration mode
yourname(config-if)#ip address 193.136.143.dd 255.255.255.0  set IP address and subnet mask
yourname(config-if)#no shutdown                              activate the interface
yourname(config-if)#end                                      end configuration mode
```

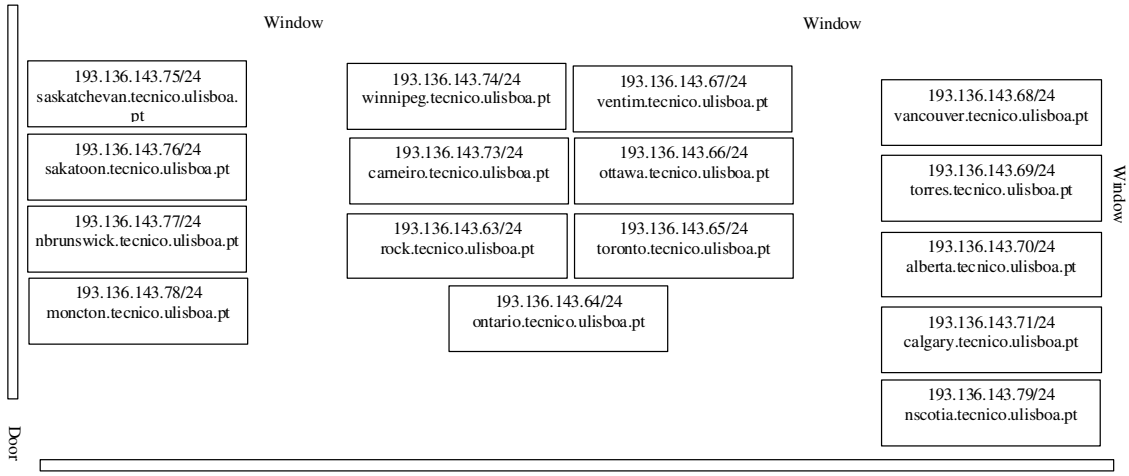

Figure 2: Laboratory map.

e) Add a default route for the router IP address 193.136.143.254 and configure the name servers 193.136.128.3 and .4. Verify that the router already has Internet access. Use the commands:

```
yourname#configure terminal                                    enter configuration mode
                                                               reading commands from terminal
yourname(config)#ip route 0.0.0.0 0.0.0.0 193.136.143.254      define default route
yourname(config)#ip name-server 193.136.128.3 193.136.128.4    define name servers
yourname(config)#ip domain-lookup                              activate name translation
yourname(config)#end                                           end configuration mode
yourname#ping google.pt                                        check Internet access at the router
```

f) Activate "NAT" (Network Address Translation). NAT allows creating a set of private IP addresses, in the range 10.10.10.0/29 for this case, that are dynamically mapped to a public IP address, according to what is necessary. Use the commands:

```
yourname#configure terminal                                    enter configuration mode
yourname(config)#interface fastEthernet 4                      enter interface 4 configuration mode
yourname(config-if)#ip nat outside                             define as public address
yourname(config-if)#exit                                       end interface configuration mode
yourname(config)#interface vlan 1                              enter interface configuration mode
yourname(config-if)#ip nat inside                              define as private address
yourname(config-if)#exit                                       end interface configuration mode
yourname(config)#access-list 100 permit ip 10.10.10.0 0.0.0.7 any
                                                               define mask for private addresses
yourname(config)#ip nat inside source list 100 interface fastEthernet 4 overload
                                                               define sharing of the public address
yourname(config)#end                                           end configuration mode
```

g) Add translation rules for the port 5001 (for the "iperf" application), both for UDP and TCP, to be mapped from the public (WAN) IP address to the IP address of your PC, you got in b). The objective of this mapping, usually called "port forwarding", is being able to have an "iperf" application in the PC that is using a private IP address, accepting connections from the Internet coming to the public IP address of the router. For that, use the commands, substituting "dd" by the PC address:

```
yourname#configure terminal                                    enter configuration mode
yourname(config)#ip nat inside source static tcp 10.10.10.dd 5001 interface FastEthernet
4 5001
yourname(config)#ip nat inside source static udp 10.10.10.dd 5001 interface FastEthernet
4 5001
yourname(config)#end                                           end configuration mode
```

h) Configure the IST name servers 193.136.128.3 and .4 in the DHCP server for the DHCP clients to use. For that, use the commands:

```
yourname#configure terminal                                    enter configuration mode
yourname(config)#ip dhcp pool ccp-pool                         configure DHCP server
yourname(dhcp-config)#dns-server 193.136.128.3 193.136.128.4
                                                               define name servers
yourname(dhcp-config)#end                                      end configuration mode
```

i) Verify if the PC has a name server configured and if your PC has Internet access through the router. If it does not, retrieve the new network configuration through DHCP. Under Liunx, you can go to the Wired settings, turn off the interface and turn it on again. Under Windows, you may execute the command "ipconfig /renew", or if you do not have permission to execute this command, disconnect and reconnect the Ethernet cable and wait.

4. Router Characteristics

a) Verify the router operating system version as well as its characteristics with the commands "`show version`" and "`show flash`". What Cisco IOS version is running in the router? How much RAM memory does the router has? How much non-volatile configuration memory does the router has? How much flash does the router has? How much free space is there in the flash memory?

b) The router has a current configuration stored in RAM, which can be seen with the "`show running-config`" command. It also has a startup configuration stored in non-volatile RAM (NVRAM), which can be seen with the command "`show startup-config`". Copy these

configurations to a TFTP (Trivial File Transfer Protocol) server in the "`nscotia.tecnico.ulisboa.pt`" laboratory PC, with the commands "`copy running-config tftp`" and "`copy startup-config tftp`". Choose a different name for each file, including always the numbers of the students of the group.

c) With the commands "`show interfaces`" and "`show ip interface brief`", observe the interface configuration. Observe the routing table with "`show ip route`". What is the maximum data rate of the router's WAN interface (FastEthernet4)?

5. Network Performance

a) Launch the "Wireshark" [5] program from a terminal. Capture network traffic with Wireshark. While capturing traffic, run the commands "ping www.cmu.edu" and "traceroute www.cmu.edu". Register in the report the results of these commands. Explain the observed results and how these applications work, based on the packet capture.

b) Verify the Internet access throughput through the router. Test, for instance, Speedtest [3] to a Lisbon server. Execute also the bandwidth testing application "iperf" [4] in a terminal of the PC and test the bandwidth for the "iperf" server in the "`nscotia.tecnico.ulisboa.pt`" laboratory PCs, using TCP, UDP, in a single direction and in both directions simultaneously. For UDP, force a sufficiently high transmission rate so that you can effectively measure the maximum throughput. Register in the report the results observed for the different cases.

6. QoS

a) Limit the router output rate to 2Mbps both for transmission and for reception, with the following commands in the router:

```
yourname#configure terminal
yourname(config)#interface fastEthernet 4
yourname(config-if)#rate-limit output 2000000 37500 75000 conform-action transmit
exceed-action drop
yourname(config-if)#rate-limit input 2000000 37500 75000 conform-action transmit exceed-
action drop
yourname(config-if)#end
yourname#
```

b) This limitation simulates a rate limited Internet access. Verify that the router is limiting all input and output traffic to 2Mbps. Check this using Speedtest [3] with and without "iperf" running at the same time using a TCP simultaneous bidirectional test. Test also Speedtest [3] with "iperf" running at the same time using UDP with a high rate in both directions. Use an "iperf" test duration longer than the Speedtest test. Execute a "ping" to "www.tecnico.ulisboa.pt". Repeat the ping with "iperf" running simultaneously using UDP with a high rate in both directions. Finally, deactivate the rate limitations repeating the commands with "rate-limit" preceded with the word "no". Register and explain in the report the results observed.

c) Delete the current router configuration by turning its power off. If you continue the work in another day, you will have to reconfigure again the router, repeating section 3.

References

[1] PuTTY: A Free Telnet/SSH Client. http://www.chiark.greenend.org.uk/~sgtatham/putty/
[2] Speedmeter. http://speedmeter.fccn.pt/
[3] Speedtest. http://www.speedtest.net/
[4] Iperf. http://sourceforge.net/projects/iperf/
[5] Wireshark Network Protocol Analyser. http://www.wireshark.org/