Redes de Computadores
Project

For this project we intend to build a computer network. We'll start by creating a webserver, then we will create a LAN for two PCs using a switch, and afterwards we will evolve in order to connect our LAN to others and create a typical corporate network.

During this project, we expect that you deliver 4 written reports that will summarize your efforts on reaching the objective. These reports are the following:

Phase	Due Date
Phase 1	Check dates on moodle
Phase 2	
Phase 3	
Phase 4	

Phase 1 – Web Server

On this first phase, you will install a Web Server on your PC and test the connection, a free web server is available on https://www.apachefriends.org/index.html. In order to test if it's working you can open a web browser and point it to your own PC using the address http://127.0.0.1/.

After testing the web server is running you can access it from another PC using your own IP address on the web browser of another PC. Use wireshark to capture the web access from another PC and compare the HTTP headers the client and the server send. If you have trouble connecting to the server check if the firewall is disabled on the PC running the server.

What to include on the report?

- Screenshots of the browser and wireshark;
- List of headers sent by the client and server and their meanings;
- Report on what was performed in order to achieve the objectives for this part.

Phase 2 – Physical Connection

Build a LAN – direct connection between two PCs

The simplest LAN topology is depicted in Figure 1, where two PCs are connected through a UTP CAT 5 cable. If you wait long enough the PCs should automatically generate a valid configuration on the network 169.254.0.0/16. You can find the automatic generated IP address using the **`ipconfig`** command.

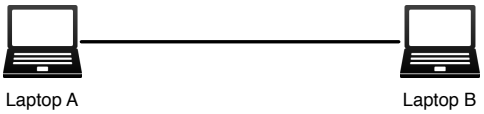

FIGURE 1: A SIMPLE CONNECTION

Since we are building our own LAN we should start by defining our own IP address range. The range attributed to your group is **`192.168.N.0/24`** where N is your group number. If you don't have a group number, you should ask your teacher for one.

Laptop A should have the IP address 192.168.N.1 and laptop B should have the IP address **`192.168.N.2`**. For now, no gateway is going to be defined.

After configuring the static IP address on each PC you should test the connectivity using the command **`ping`** and a web browser pointed to the previously configured web server.

WHAT TO INCLUDE ON THE REPORT?

- Screenshots of the PCs configuration screens;
- Outputs of commands;
- Screenshots of your web browser accessing the Web server on the other laptop;
- Photos depicting the physical connections;
- Report on what was performed in order to achieve the objectives for this part.

BUILD A LAN – CONNECTION VIA SWITCH

In order to connect more than 2 PCs we need to add a switch as seen on Fig. 2. Please note that inserting a switch has no interference with the configuration of the laptops, and that the ARP Cache is the same as before. How can a PC know if it is connected to a switch? Is **`traceroute`** useful in this situation?

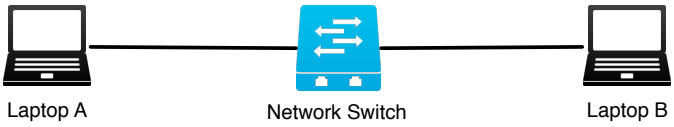

FIGURE 2: LAN TOPOLOGY

After checking that everything is working as before you can now connect another PC to the network, use **`ping`** and the web browser to check if connectivity exists between all PCs.

Hint: Don't forget that your switch may have some previous configuration, please reset it if it doesn't work as expected.

WHAT TO INCLUDE ON THE REPORT?

- Outputs of commands;
- Screenshots of your web browser accessing the Web server on the other laptop;
- Photos depicting the physical connections with the switch;

- Report on what was performed in order to achieve the objectives for this part, including answers to the questions.

CONNECT TWO LANS WITH A ROUTER

Let's continue by connective multiple LANs using a single Router. To do so use an available port on the switch to connect to a network interface on the router. Figure 3 shows the expected topology. Note that since you are using a new network you should have a difference address space for it. To do so you should subnet the address space given to your group. Router interfaces should use the last available address of the subnet address range for each interface. Don't forget to also configure the default gateway on the different Laptops.

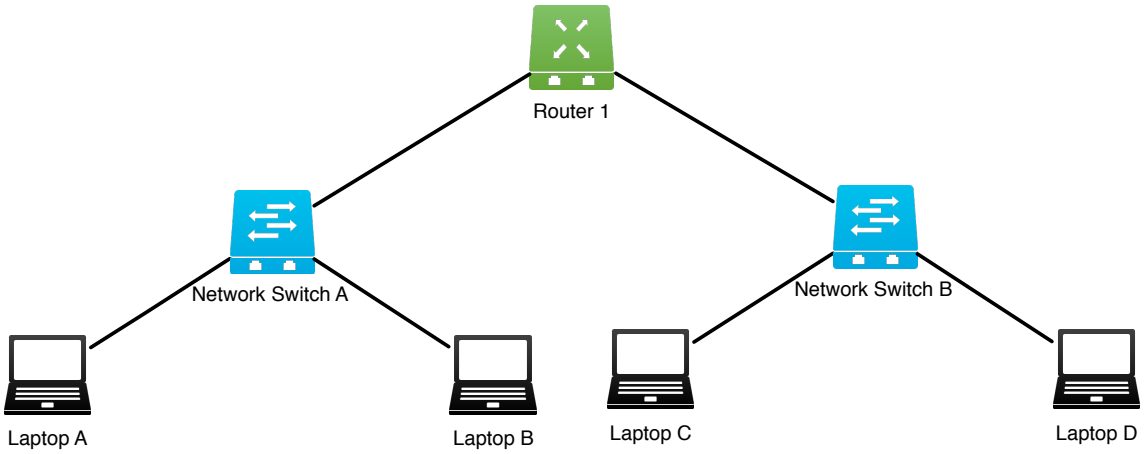

FIGURE 3: TWO LANS CONNECTED

Test all configurations using the previous mentioned commands and observe that the MAC addresses from Laptops on the Left LAN do not appear on the ARP caches of PCs on the Right LAN. Also check the routing table on the router with the command **`show ip route`**.

When pinging from Laptop A to Laptop D use *wireshark* to check what happens to the TTL field on the IP header.

Observe if Laptop B can use *wireshark* to capture the traffic from Laptop A accessing the webserver of Laptop C.

Hint: Don't forget that your router may have some previous configuration, please reset it if it doesn't work as expected.

WHAT TO INCLUDE ON THE REPORT?

- Updated screenshots of the PCs configuration screens;
- Outputs of commands;
- Photos depicting the physical connections with the router;
- Router configuration;

- Wireshark screen captures of packets involved on the tests (Web access, ARP and ICMP) on the multiple laptops.
- What was performed in order to achieve the objectives for this phase, including answers to the questions.

PHASE 3 – GO VIRTUAL

In this phase we will convert our work into a virtual environment. Virtual environments allow us to build a much larger network without the needed access to the physical devices. To build our topology on a virtual environment you need to choose between a simulator or an emulator. Simulator are more convenient for small setups, however are prone to bugs on the simulation process. Emulators provide a more authentic experience since they execute the binary image of the physical device while emulating the hardware. For this work, we will use EVE-NG an emulator. Figure 4 show what the current topology would look like in EVE-NG.

Instead of using only Cisco devices we will add another vendor, Mikrotik. The emulator is able to emulate both Cisco and Mikrotik devices.

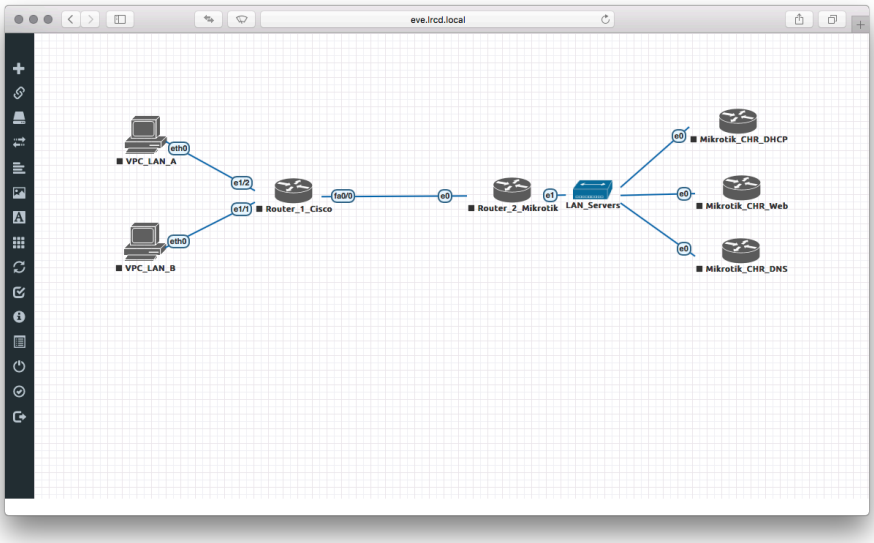

FIGURE 4: EVE-NG SCREENSHOT

The emulator is a Web application running on powerful hardware in order to emulate all devices. You only need a web browser and a telnet client, Putty on windows, on Mac/Linux the built-in client is enough. Install the client pack from http://www.eve-ng.net/if putty doesn't open automatically.

The emulator is available at http://eve.lrcd.local - this URL is available from the Internet if you use b-ON VPN available from https://www.net.ipl.pt/servicos/vpn/vpnbon/ . A user and password will be provided to you by your teacher for EVE. The software used (EVE – Emulated Virtual Environment) is in beta stage, so expect a lot of bugs.

With the virtual environment, it's easier to expand our network. In this phase, we will connect our two LANs (A and B) to Server LAN using a Transit Network. LAN T will be considered a transit network between router 1 and router 2. LAN A will be converted to our user network for department A and LAN B for the users of department B. LAN C will be our server network. Figure 5 shows a drawing of the network topology.

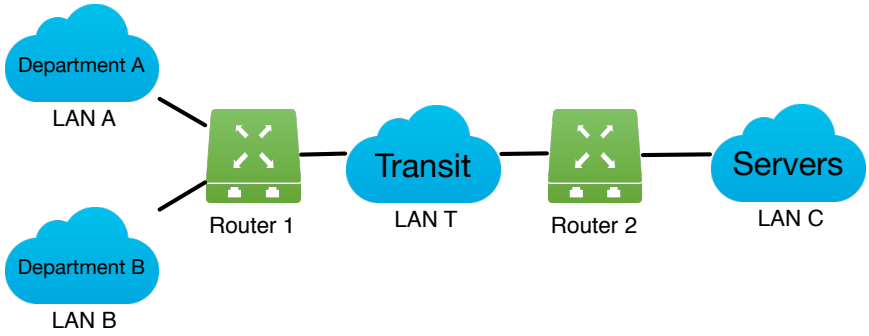

FIGURE 5: NETWORK TOPOLOGY WITH MULTIPLE ROUTERS

In order to obtain the number of clients connected to LAN A and B you should use the following formula:

$$\text{Clients}_{LAN_A} = \left(\sum_{k=0}^{n} studentnumber_k\right) mod\ 100$$

$$\text{Clients}_{LAN_B} = \frac{\text{Clients}_{LAN_A}}{2}$$

Which represents the sum of all group members (n represents the total number of students) modulo 100 (select only the last two digits of the sum result).

The number of clients at LAN B should be half of the ones from LAN A.

LAN T should use a /30 address, LAN C should have the largest remaining contiguous block of you address space.

Figure 6 shows the already configured topology as provided to you. You can find it on \RCp\RCP-ProjFinal.unl inside EVE interface. This means that you do not need to change the topology, you only need to start the devices and configure them.

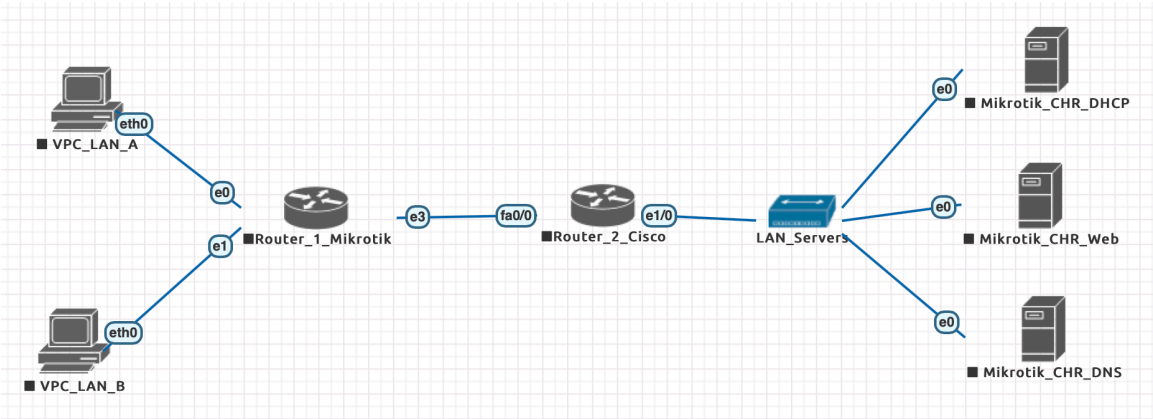

FIGURE 6 - NETWORK TOPOLOGY

The virtual environment is shared between all, so the system reinitializes frequently in order to remove devices that were left running unattended. Since the environment is shared, if everyone leaves the work to the last date the load on the server will be high and performance will be degraded, ensure that you start working early to avoid issues.

Test connectivity between networks and routers. Don't forget to adjust routing tables and default gateways on the PCs. Test if everything is working as expected, use the previous knowledge in order to test everything.

WHAT TO INCLUDE ON THE REPORT?

- IP Address distribution;
- Command outputs in order to test connectivity and routing;
- Configuration of different devices and networks (including the address space used on each LAN);
- Command outputs in order to test connectivity and routing;
- What was performed in order to achieve the objectives for this phase.

PHASE 4 – DEPLOY SERVICES

In this phase we will upgrade our network to a more realistic one by using DHCP and DNS in order to provide an easier experience to our users. Additionally, we will also add a webserver what will be available to the users. In order to achieve this, you must deploy 3 servers on the server LAN. A server for DHCP, another one for DNS and the third one for HTTP.

Users of LAN A and B should be able to receive a network configuration automatically and also be able to access www.company.com server by the web server. Figure 7 shows the expected network diagram. You can test the DNS using **`nslookup`**, and DHCP on the clients using **`ipconfig /release`** or **`ipconfig /renew.`**

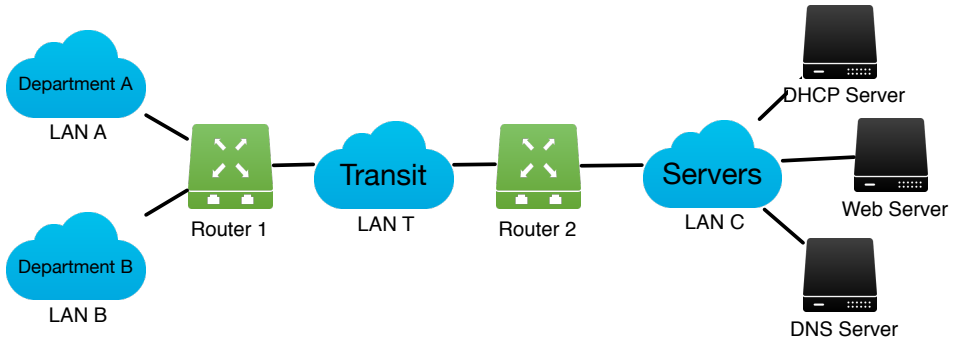

FIGURE 7: NETWORK WITH SERVICES

Note that since we are using Mikrotik Routers to provide the services, some of the services do not require configurations, for example Web, since it's already enabled on the router. To test DNS

perform a ping using the correct name, to test DHCP show the outputs of “ip” commands, and for Web use telnet to the correct port. Telnet is available on the Cisco router.

WHAT TO INCLUDE ON THE REPORT?

- Configuration of different devices and networks (including the address space used on each LAN);
- Command outputs in order to test connectivity, routing, DNS, DHCP and Web access;
- What was performed in order to achieve the objectives for this phase.

This is your last phase, by this time you should be able to understand all the concepts and protocols related with building a simple corporate network.

In order to instruct yourself as how to configure the newer devices, use the following manuals:

Mikrotik:

DNS - https://wiki.mikrotik.com/wiki/Manual:IP/DNS#Static_DNS_Entries

DHCP - https://wiki.mikrotik.com/wiki/Manual:IP/DHCP_Server