# Lab3: Routing, Network Connectivity and Address Configurations

in Cisco Packet Tracer

Romaric Duvignau

February 3, 2025

**Computer Communication Remote Lab**

Department of Computer Science and Engineering,
with contributions and support from Hans-Martin Heyn,
Roman Melnik, Ali Salehson and Marina
Papatriantafilou.


Lab3, 10 tasks, 32 questions + 1 optional task

## Contents

**1 Introduction to the virtual lab room** **1**

**2 Routing and Router Configuration** **2**
2.1 Console connection . . . . . 2
2.2 Remote connection and routing . . . . . 3

**3 Ping, Tracert and Packet Capture** **4**
3.1 Ping command . . . . . 4
3.2 Tracert command . . . . . 5

**4 IP Address Configuration and Subnetting** **5**
4.1 Introduction: IP addressing . . . . . 5
4.2 Create a single LAN . . . . . 7
4.3 Reconfigure the single network into a number of subnets . . . . . 8

## 1 Introduction to the virtual lab room

The "real" lab starts now so please enter in our virtual lab room. To do so, start by downloading the packet tracer file representing our room: lab3.pkt from `http://www.cse.chalmers.se/~duvignau/packet-tracer-lab`.

Open the file in Packet Tracer and you should see the same network as Figure 1.

**Tips**

If you have problem seeing the different elements because of the background picture, just press **Shift + i** then click **Reset**.

The computers in the lab are configured in a *Peer-to-Peer LAN* connection. As described in the preparation instructions, they are connected two by two to switches and each switch is connected to its own router and finally the routers are interconnected forming a ring.

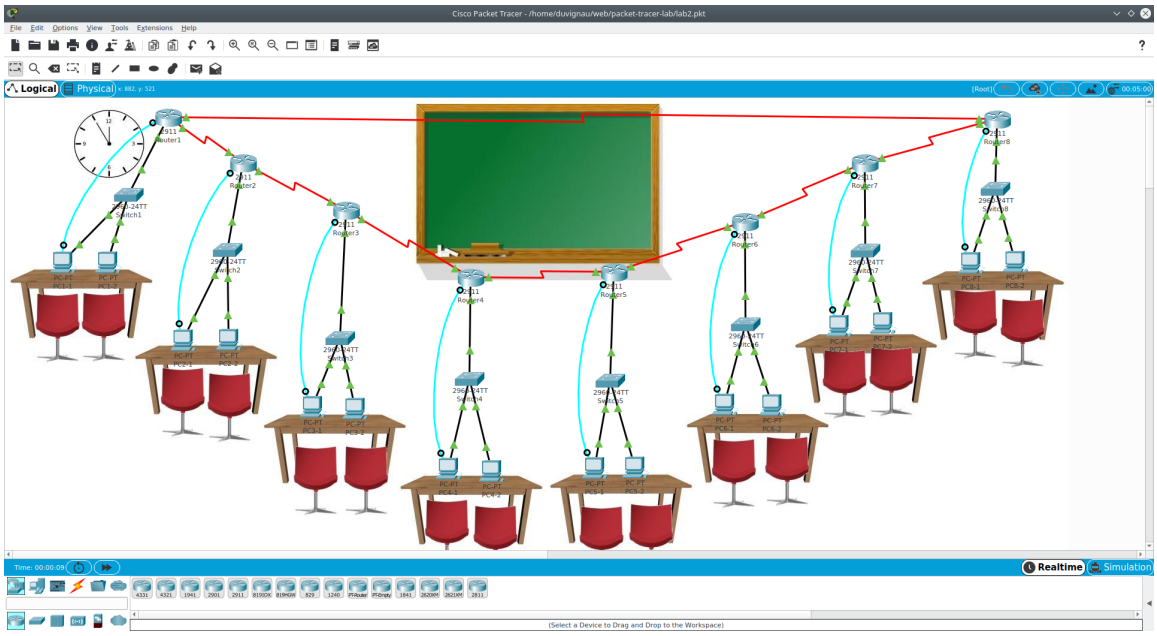

Figure 1: Our virtual lab room in Packet Tracer: your table is *your group number modulo 8 plus 1*, so **please take a seat!**

First, you should find out which seat you should "take" in the virtual room. Just compute **your group number modulo 8, plus 1** to find "your table" in the room, for instance "ComputerCommunicationLabGroup 88" gets $88\%8 = 0$, so the group should use PC1-1 and PC1-2. Let's call these two computers sitting on "your table" in the following **PCX-1** (or simply **your computer**) and **PCX-2** (or **your neighbour's computer**); here $X = 1 + (N\%8)$ where $N$ is your group number. Those 2 neighbouring PCs are connected to the same switch called in the following **your switch** which itself is connected to **your router**.

**Tips**

In the following, always wait a little bit (20-30sec) after loading the packet tracer file so that the network stabilizes (you'll notice computers are changing IP addresses at the beginning).

## 2 Routing and Router Configuration

Configuration of routers is outside the scope of this course, but we will now look at **how the routers are already configured**. Each router is configured to be your default gateway and receives all traffic from your network that is destined for other networks. You will soon investigate two router commands: "**show run**" and "**show ip route**", both of them can be entered either using a **telnet session** or via the **router's console**.

### 2.1 Console connection

Let's first try the console connection first. If an error is made when configuring the router, it may not be possible to connect to it over the network anymore. Therefore, the router has a console interface (with a dedicated serial communication cable), which is always possible to use when you have physical access to the router. Identify which computer on your desk has a console access to the router and open **Terminal** on the PC's Desktop (this is equivalent of Windows' "Hyper Terminal"). Leave default parameters unchanged and press "**OK**" and you will be able to communicate directly with the router in console mode.

First press "**Enter**" as instructed then the first password asked is "**cisco**", then to be able to configure the router, another login is required using the "**enable**" command and the password is this time "**class**". Now you are working in privileged mode and configuration is possible. Please don't try any router configuration!

**Task 1.** After successfully connecting to the router in privileged mode, run the command "`show run`" (showing running configuration) and read throughout the output (try to figure most of it by yourself). Insert a screenshot and answer the following questions:

(a) What is the IP address of the default gateway of your computer? Does that match one of your router's interfaces?

(b) Which router interface belongs to your network and what IP address does the interface have?

(c) What routing protocol is configured for the router and for what networks?

**Tips**

To see "more" of the output of commands in the router command-line's interface, just press **Enter**.

### 2.2 Remote connection and routing

Now let's try accessing the router remotely using a **telnet session**. First **pick a router that is 3 hops away** (eg Router4 is 3 hops away from Router1) from *your local router* (that is the router connected to your local switch and your default gateway). Now on **PCX-2**, run telnet to connect to the *foreign* router using the IP address of one of the appropriate interfaces. Start **Telnet** to connect to the router you have picked. After successful authentication (the login and passwords are the same as before), you are in user mode where some of the router settings can be checked. For the next task, we only need **user privileges**.

**Tips**

You'll find telnet on the **Desktop**: click on an icon for **Telnet / SSH Client**, then choose **Telnet**. Telnet is also available using its usual command-line interface in the *Command Prompt* and works on port number 23 (dedicated to telnet protocol) which is the default port number of the command when left unspecified.

**Task 2.** After successfully connecting to the remote router in user mode, run the command "`show ip route`" (showing routing table) and insert in your report a screenshot of the result, and answer the following questions:

(a) What are the networks (prefix and mask) that the router you've picked has direct connection with? Differentiate between the local interfaces and a direct link.

(b) Determine the route from the selected router to your LAN from the routing table. What is the interface to go to your LAN?

(c) Check how many hops away there are to reach the LAN according to the routing table. Determine possible routes to your LAN by examining the network topology. Does the route provided correspond to the best route possible? Hint: Cisco routers show the metrics using $[120/x]$ notation where $x$ is the metric (here the hop count).

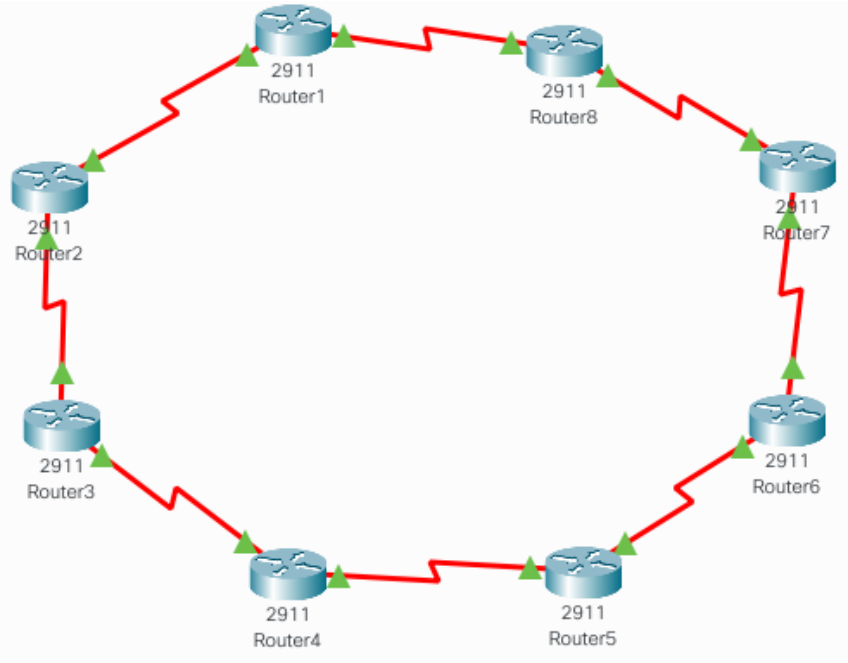


Figure 2: The routers form what we call a "ring topology", a very well known and efficient configuration to connect different machines.

**Hint**

A **hop** is a unit of distance in networks: "$n$ hops" means that $n$ link traversals are required to reach the destination, regardless of the capacity and traffic on the different links.

The maximum number of hops in the full network refers to the maximum number of router traversals to reach any computer on the network, and this **from any starting router** (not only yours).

# 3 Ping, Tracert and Packet Capture

## 3.1 Ping command

The ping command is an important network tool in order to check connectivity in a particular network.

**Task 3.** Ping your neighbour's computer (PCX-2), and insert a small screenshot in your report.

(a) How many IP packets are sent by the host in total when you run ping? How many bytes are used by default in each packet for ping?

(b) What information do you get from running the ping? The answer must be the interpretation of the result and not a copy of what is displayed.

(c) Now ping 1 computer located on one of the other tables. What are the main differences you notice in the output compared with your neighbor's computer's response?

**Tips**

Remember that to copy-paste one device's IP address, you can **Inspect** a device and choose "**Port Status Summary Table**". To inspect elements, use the **Inspect** (Magnifying glass) action in the Action bar next to *Select*.

### 3.2 Tracert command

In the next task, we will run the command `tracert` from your computer to a computer in some other group's LAN. Check carefully the trace hop by hop and look at the network topology.

**Task 4.** First pick 2 computers that are at *different hop-distances* from your local computer.

(a) Execute `tracert` for each of them and insert a screenshot with all output.

(b) How many hops do you get in each case? How does this compare to the distance metric provided by the router when you run "`show ip route`"?

(c) What about your neighbouring computer in your LAN? How many hops should you get? Check your answer by using tracert.

**Tips**

Since there will be a lot of generated packets in **the next task**, you may want to accelerate the animation speed (slide the bar to the right) or just click rapidly on ⏭, but of course, you are going to miss watching Cisco's cutting-edge animations!

Start the *simulation mode* in order to visualize local traffic. Run the command `tracert` again but to a computer in another group *2 hops away from your router* and answer the following task.

**Task 5.** (a) What are the **Network Layer** protocols (+ code and type of messages) involved in the operation when you run "`tracert`"? Insert a screenshot with the simulation panel and the PDU Information.

(b) How many times is each *tracert* round repeated?

(c) Do a `ping` to the same destination of *tracert*. What messages (protocol and type) are used? What's the difference with those of the `tracert` command?

**Hint**

You may need to analyze deeply the captured packets and look for the appropriate layer or *PDU details*. Upon inspecting a packet, you can check **Inbound/Outbound PDU Details** on the right of **OSI Model** tab to get more information about header content.

## 4 IP Address Configuration and Subnetting

### 4.1 Introduction: IP addressing

To start with this set of tasks, reload the lab room file used in the previous tasks: lab3.pkt[1]. Here again, **PCX-1** or "your computer" refers to the computer you have used in the previous tasks, and **PCX-2** is the other computer connected to the same switch.

[1] http://www.cse.chalmers.se/~duvignau/packet-tracer-lab/lab3.pkt

**Task 6.** (a) What is the IP address and subnetwork mask of PCX-1?

(b) What is the corresponding binary representation of the IP address of PCX-1?

(c) What part of the IP address represents the network prefix and respectively the host part? Separate the binary representation into network prefix and host parts.

(d) What is PCX-1's MAC address for its active interface?

**Hint**

You can find those information at several places, but one that gather them all is always the **ipconfig /all** command-line.

### 4.1.1 Changing the IP address within the same subnet

Now you are going to assign a new IP address to **your computer**. If your computer's IP address was **A.B.C.D**, your computer's new address should be **A.B.C.(20+N)** where **N** is replaced by your *group number*, eg if "ComputerCommunicationLabGroup 88" had address **200.100.50.11**, its new address should be **200.100.50.108**. Now, change manually the computer's configuration to use the new address[2] and keep the rest of the parameters unchanged!

**Tips**

The address can be changed from the network parameters of your device. Click on the device you want to configure, then **Desktop** and finally **IP configuration**. To assign a fix IP, you need to switch from DHCP to **Static** and provide the IP address. If you press press enter then, subnet mask is set automatically.

Once you have changed your IP address you might realize that you also need to manually set an address for the default getaway if you want to send packets outside of your own subnet. To do so, you can just set the network prefix as the same one as the one of your IP address and use **1** for the host part, or alternatively you can switch back to DHCP and write down your default gateway address before switching to static and fill up the address.

**Side-note**: you can also look at the other TCP/IP configuration parameters that are possible to change (but leave them as they are) and try to explain them.

**Task 7.** (a) After changing your computer's IP address, ping your starting computer from the other computer at the same workplace i.e. **PCX-2** should ping **PCX-1**. Does it work? Can you explain shortly why?

(b) Now ping from **PCX-1** a computer at another table than yours, and insert a small screenshot in your report. Since you want to communicate with a computer beyond your subnet, don't forget to set first the **default gateway** to the right value in the IP configurations!

(c) Does it work this time? Which entry in your router's forwarding table is used when the computer you have pinged **answers** to your ping? (remember to check the entry corresponding on the **response** and not the packet you've sent!)

**Hint**

You can find a router's forwarding table by inspecting it: use **Magnifying glass icon** in the menu bar then left click on your router and choose "Routing Table".

[2] knowing you, perhaps you've tried to steal your neighbor's address, but packet tracer forbids you to do so!

**Tips**

As with an ordinary prompt, you can access the history with ↑ and abort with **Ctrl+C**.

### 4.1.2 Changing IP to a different subnet

For the next task, use the **simulation mode** to simulate a few frame transfers and identify the reason why your packets were dropped by inspecting packets as in the preparatory instructions (click on packets and identify the explanation while scrolling through layers with the "Next layer" button).

**Tips**

While in simulation mode, feel free to uncheck **Misc** → **STP** in **Edit Filters** because we will not be interested in those packets in this lab. Same applies to **CDP**.

**Task 8.** Change your computer's address to **A.B.C.(150+N)** where **N** is replaced by your *group number*, eg "ComputerCommunicationLabGroup 88" should assign the address **A.B.C.238** and ping again your neighbor.

(a) Why doesn't it work this time whereas last time it was fine?

(b) Where were the packets actually dropped? Use the hint below to locate the reason.

Now change also your neighbor's address to be **A.B.C.(150+N+1)** where **N** is your group number (that is your current IP "+1"). Ping PCX-2 from PCX-1, and insert a small screenshot in your report and answer the following:

(d) Does it work this time and why?

(e) What about if you ping a computer on another table, does it work and why? Check the following hint when writing about the reason.

**Hint**

You have changed the IP address of your computer and specifically the network part which results in that the network part of the computer's IP address differs now from that of the **default gateway**'s subnet.

## 4.2 Create a single LAN

For this last part, we won't need the routers so delete them or download and open the lab room without them: lab4.pkt [3].

From now on, your computer's new address should be **200.150.100.N** where **N** is replaced by your *group number*, eg "ComputerCommunicationLabGroup 88" should assign the address **200.150.100.88**, and also update your subnet mask to consider only 24 bits in the network part of the address. Do the same for your neighbor so that its new address is **200.150.100.(N+1)/24**.

As if you were also acting for other groups performing the same task that you did at your table, change now all the other PC IPs in the virtual room to be in the range **200.150.100.0/24**. You can choose any IP address for the other computers as long as your network is working.

**Tips**

You may want to save your network now.

[3] http://www.cse.chalmers.se/~duvignau/packet-tracer-lab/lab4.pkt

Next step is that you will interconnect your network part to the other groups' parts using switches to build one single IP network for all computers allowing them to communicate directly.

**Task 9.** (a) Connect your switch with another group's switch using crossover cable. Then interconnect all switches such that all computers can communicate with each other. Once you have tested the connectivity within the large network and made sure it works, take a screenshot of your master piece and include it in your report.

(b) Explain why all computers can now be reached directly by your computer, and compare with Task 8 where the same was not working because computers were part of different subnets.

(c) Note that currently there is no default gateway for the new IP network. What would be the purpose of adding a default gateway to this network?

**Hint**

There are many different solutions to the previous task (try to figure out what could be the other possible designs), the only important thing is that the full network is directly interconnected and all computers now belong to one large IP network. You can choose to keep the routers or not.

**Tips**

It is recommended to save your work at this point.

### 4.3 Reconfigure the single network into a number of subnets

The single IP network will be reconfigured into a number of subnets. Your next task will be to divide the address space (200.150.100.0/24) into **8 equal-size subnets**, i.e. to create one subnet for each workplace. You will again change the IP address of your computer, making your network part different from the one of all other workspaces. Note that creating 8 subnets is sufficient for connecting each group's computers together and still leaves plenty of room for the IP addresses of computers within each subnet.

**Task 10.** (a) How many bits should be used for the subnet part (subnet mask) and for the host part in each subnet? What is then the subnet mask to use in dot-decimal notation?

(b) Reproduce and complete Table 1 which shows the address details for each subnet.

(c) What does it mean when an IP address has the host part as all zeroes (for example `192.168.1.0/24`) and when the host part is all ones (eg `192.168.1.255/24`)? Use the following hint.

**Hint**

The first address of a subnet is usually forbidden to use as it is used to identify the network as a whole, and the same holds for the last address as it is dedicated to broadcast.

You will now perform a logical separation of the subnets. Workspace 1 (PC1-1 and PC1-2) should use subnet 1, workspace 2 should use subnet 2, etc. Leave the *first* available host address for a possible router interface connected to your subnetwork, i.e. for the default gateway (configuring the router is outside the scope of this lab). One computer should use the *second* IP host address in the subnet and the other uses the *last* IP host address in the subnet.

**Configure now all computers with these new IP addresses!** Make sure to also configure the new subnetwork mask!

| SN# | Subnet Address | Host IP Addresses | Broadcast Address |
|---|---|---|---|
| 1 | 200.150.100.0 | 200.150.100.01 up to 200.150.100.30 | 200.150.100.31 |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |

Table 1: Separation of the IP addresses into different subnet spaces.

**Tips**

It is recommended to save your work at this point, but of course, use a different name!

The following task is optional but recommended. Moreover, solving it correctly can compensate for missed points in earlier tasks.

**Task 11.** Start simulation mode, then send a ping from **PCX-1** to **PCX-2**, and examine the ARP and ICMP captured packets in the simulation panel. For each of the following items, identify a packet and **copy-paste** the reason/explanation found in the PDU information (retrieved on inspecting individual packets); insert a screenshot of the simulation panel in your report and discuss the following:.

(a) why the ARP request has been sent to every switch.

(b) why the ARP request is dropped by other computers than PCX-2.

(c) what is the moment when your local switch updates its MAC table.

(d) why subsequent pings do not generate an ARP flood in the network anymore.