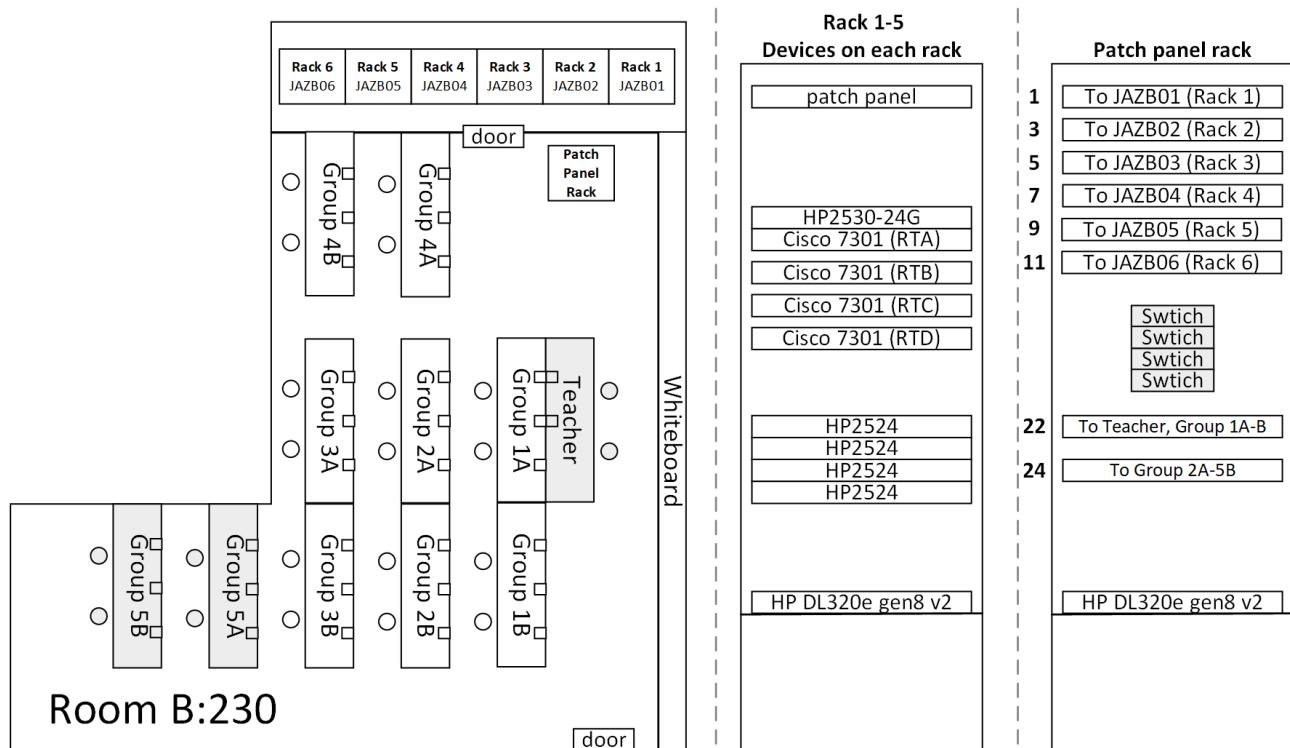


IK1203 Lab3

1.1 Networking Lab Infrastructure

The lab infrastructure consists of six racks in a small server room adjacent to room B:230. Each rack has multiple devices. Some ports on these devices are connected to a patch panel located at the top of the rack. The patch panel is interconnected with another patch panel located in the patch panel rack in room B:230. They are arranged in sequential order by rack number, with rack 1 at the top and rack 6 at the bottom.

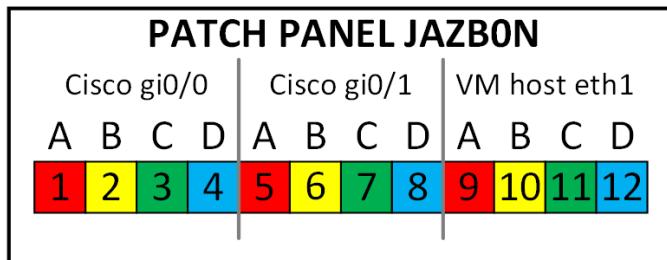


Rack 1-5 have an identical setup with the following equipment.

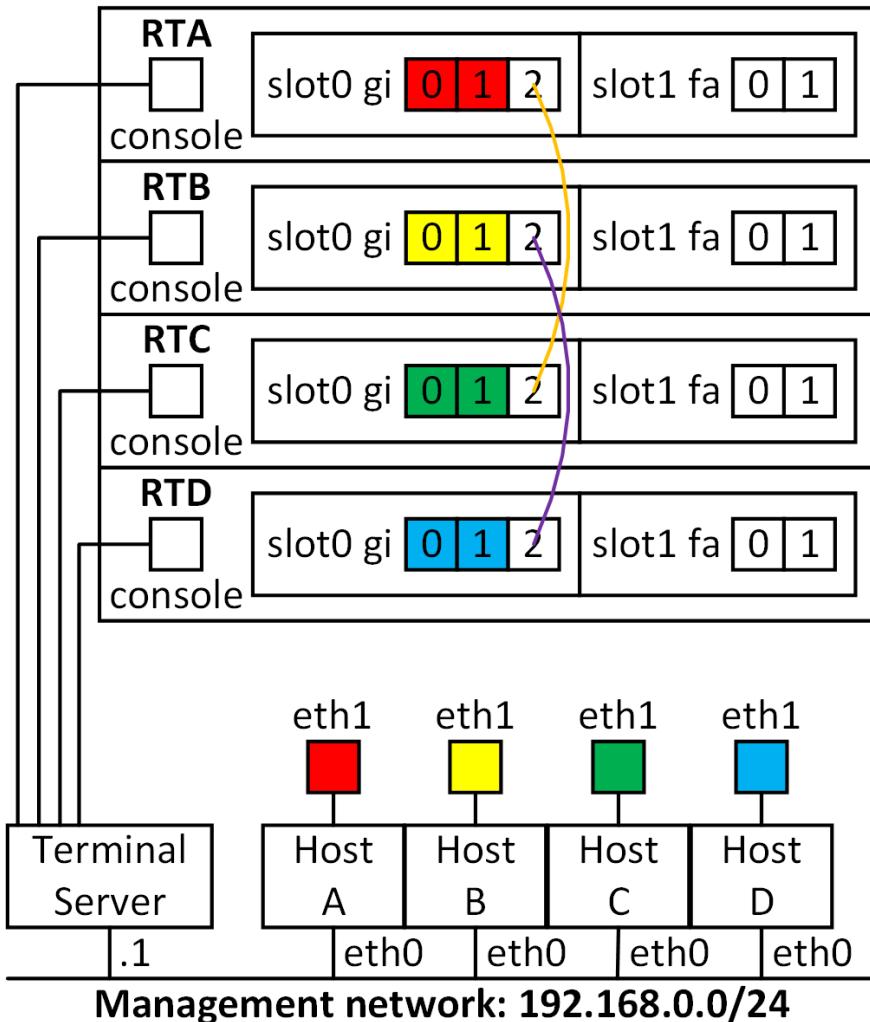
- A patch panel that connects to the patch panel rack
- Four Cisco 7301 routers (RTA-RTD from top to bottom).
- Four 100Mbps HP2524 switch.
- HP DL320e server that hosts 4 lab VMs, which are to be used as hosts (host A-D) in the lab. They run Ubuntu server 14.04.2 LTS.

Devices on each rack are connected to the patch panel according to the topology in the figure below. Throughout the lab session, students will sit and work in groups. Two student pairs will configure different devices on the same rack. In particular, group 1A and 1B work with devices on rack 1, group 2A and 2B work with devices on rack 2, and so on. Rack 5 is reserved for the teaching staff's setup. Rack 6 contains other equipment not for this lab. However, the management network is patched to the first four ports of Rack 6.

IMPORTANT: We limit the number of students to 16 per session, and they will use Rack 1-4 in their lab.



N is the rack number



Router console access:

SSH to 192.168.0.1

with port number:

$2000 + (X-1)*4 + Y$

X is the rack number
(1-5)

Y is the router below:

RTA: 1

RTB: 2

RTC: 3

RTD: 4

Host access:

SSH to 192.168.0.XY

X is the rack number
(1-5)

Y is the host below:

Host A: 1

Host B: 2

Host C: 3

Host D: 4

1.2 Accessing Devices in Networking Lab

All routers and lab VMs can be accessed via the management network. Therefore, you must first connect to the management network. There are two ways that you can connect your laptop to the management network as follows:

- Using a cable to connect your laptop to one of the management ports (port 1-4 on the patch panel).
- Using WiFi, you can connect to the *networklab* WiFi.

You should get an IP address automatically from the 192.168.0.0/24 subnet. **You MUST NOT set your IP address manually when connecting to the management network!**

If you use your laptop as part of the network topology, you will have to connect to the management network through WiFi. It will not be a problem to connect to two different networks simultaneously as the management network and your network topology using different subnets. It will not interface with each other (given that you configure them correctly). However, you will no longer be able to connect to the Internet. Thus, you may need to use another device (such as your mobile phone) to access Canvas while using your laptops as parts of the network topology. Alternatively, you can save section 3 lab instructions locally on your computer for offline usage.

SSH Client Application

You will mainly use SSH to access networking devices (i.e., routers and lab VMs) in the lab. Therefore you must have an SSH client application installed on your laptops. If you use Linux or MAC operating systems, an SSH client application should already be installed, and you can launch a terminal application and run ssh via a command-line interface (CLI).

For students who use Windows, we recommend that you use [PuTTY](#) as an SSH client application. You will need to download and install [PuTTY](#) on your laptop before coming to the lab session.

Accessing Cisco routers (RTA-RTD)

The console port of every router is connected to the terminal server. Thus, you will have to access the router console via the terminal server. This can be done by connecting to the management network (as described earlier) and SSH to the corresponding router. Note that the routers are relatively old and require you to use specific options when SSH. You must run the following command on your laptop: (password: time2work)

```
ssh -oHostKeyAlgorithms=+ssh-rsa -oKexAlgorithms=+diffie-hellman-group1-sha1 -c  
aes128-cbc student@192.168.0.1 -p 20XX
```

where 20XX is the port number. See details on which port connects to which router in the Table below.

Make sure to use a hyphen (-) in the SSH command above. The command will not work if you use the en dash (–) or the em dash (—).

For Windows users, it is recommended to use PuTTY to access the routers (login as student password: time2work). If you have problem, try to set parameters under Connection->SSH->Kex and Connection->SSH->Cipher.

Router	Rack1	Rack2	Rack3	Rack4
RTA	2001	2005	2009	2013
RTB	2002	2006	2010	2014
RTC	2003	2007	2011	2015
RTD	2004	2008	2012	2016

After you establish an SSH connection to a router, you should see an **OK** message, press enter twice, and verify that you get access to the router console. The router has likely been reset earlier, and you will see the message below:

Would you like to enter the initial configuration dialog?
[yes/no] :

Just answer **no** and press enter. Then, press another enter to accept the default answer to the next question. At this point, you should be connected to a router at the user EXEC level.

Accessing lab VMs (host A-D)

Our lab VMs run Ubuntu 14.04.2 LTS. Thus, you will see that a host-related command in our lab instruction is based on a command for Ubuntu. Other Linux distributions might have different locations of files and a different name for configuration script.

To access lab VMs, you must connect to the management network and SSH to a host that you want to access. The IP addresses of the hosts are based on the rack numbers, as shown below:

To access rack x host A, use the command: `ssh -Y student@192.168.0.x1`

To access rack x host B, use the command: `ssh -Y student@192.168.0.x2`

To access rack x host C, use the command: `ssh -Y student@192.168.0.x3`

To access rack x host D, use the command: `ssh -Y student@192.168.0.x4`

For example, you will SSH to 192.168.0.11 to access host A on rack 1 and 192.168.0.21 to access to host A on rack 2, and so on.

The credentials for lab VMs are: **username:** student **password:** time2work

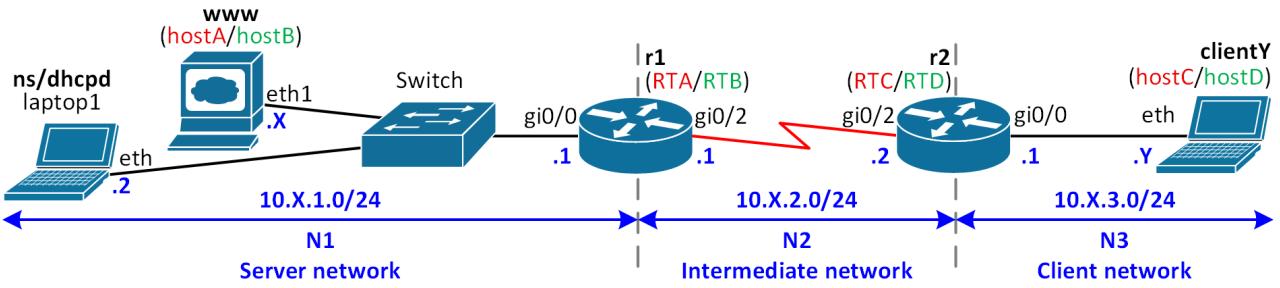
For Putty, Host Name (or IP address) should be the IP address given in the above commands, and the port number is 22.

The lab VMs are connected to the management network on eth0. Therefore, **you MUST NOT change eth0 configuration on lab VMs!** (If you do, the lab VM will be disconnected from the network.)

Network topology

You will put together a small network with basic Internet services, as shown in the figure below. This is the same network topology that you use in lab 2. In this lab, one of your laptops is used as laptop1 in the network topology. Laptop1 runs the server VM with the DHCP and DNS services. Laptop2 is not connected to the network topology. Nevertheless, each group will connect both laptops to the lab's management network using WiFi and configure different devices in the network topology.

Each student already has a unique assigned number that you use in lab 1 and 2. You will use the assigned number of the student whose laptop is used as the server (laptop1 in the figure below) as your group number in your configurations. Both students are expected to configure devices simultaneously. Thus, it would help if you decided on who will configure which devices before coming to the lab session.



NOTE: The IP address comprises two parts: network identifier and host identifier. We write these two parts separately in the figure above. For example, the laptop1's eth IP address is 10.X.1.2 with a /24 subnet (i.e., netmask 255.255.255.0). We write the network identifier as 10.X.1.0/24 and the host identifier as .2.

3.1 Setting up the Network Topology

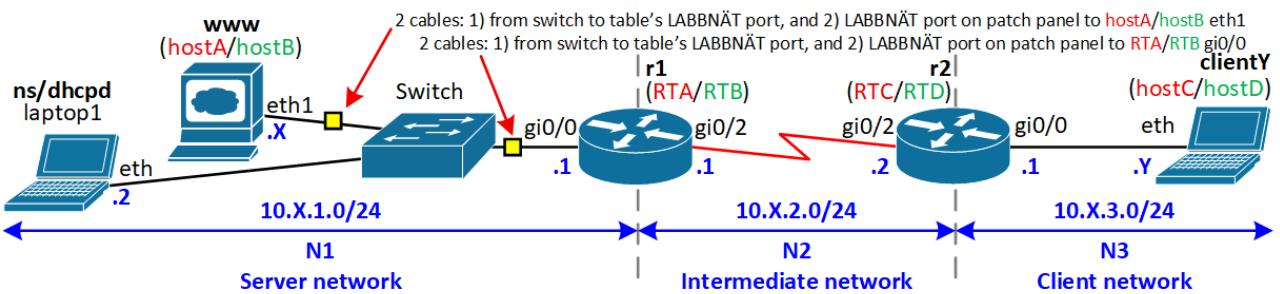
You will start by setting up the network topology as shown above. In particular, you will connect cables to different devices. Most devices are physically located inside the server room and are connected to your table's patch panel. You can see the details of how the patch panel is connected in Section 1.1 Networking Lab Infrastructure. You will use different devices for different roles as shown in the table below.

Group nA	Group nB	Role as per the network topology
RTA	RTB	r1
RTC	RTD	r2
Host A	Host B	www
laptop1	laptop1	ns
Host C	Host D	clientY
Switch	Switch	Switch
6 straight-through cables	6 straight-through cables	Twisted pair Ethernet cables

You can find cables and a switch nicely placed on the table. **We expect you to roll the cables and place the equipment neatly on the table at the end of the lab.**

The gigabitEthernet 0/2 interface on RTA and RTC (similarly, on RTB and RTD) is already connected with a cross cable. You will connect the remaining equipment. You may use straight-through cables for all connections. It is ok to use a straight-through cable to connect a router to a host (e.g., lab VMs and your laptops) because both lab VMs and your laptops have auto-sensing capabilities that detect the cable type and work correctly with either a crossed or straight-through cable.

You must place the switch on your workbench and connect different devices to it. Thus, in practice, you will need multiple cables for patching, as shown below.



After you are done connecting all cables, call the lab assistant to verify that everything is correct.
You need the lab assistant's approval before you proceed!

3.2 Configuring Routers

To configure r1 and r2, you need to first connect to our lab management network, which is reachable via a WiFi network called ***ik1203***. You will need to authenticate using the password ***ik1203lab3***. You should get an IP address from the **192.168.0.0/24** network via the DHCP.

After you are connected to the management network, you can connect to the routers following the instructions in Section 1.2 Accessing Devices in Networking Lab. You can work on the routers at the same time (each student works on one router).

Before you start configuring the router, make sure that there is no previous configuration on the routers. In particular, if the router is clean with no previous configuration, you should see the message below after you SSH to the router.

```
Would you like to enter the initial configuration dialog?  
[yes/no] :
```

If you don't see this message, you have to erase the previous configuration. We strongly recommend that you should call a lab assistant to help you erase the previous configuration.

To erase the routing configuration, do the following.

- Run `erase startup-config` command in privileged mode
- Restart the router using the `reload` command (confirm and **DO NOT** save the configuration!)
- After the router reboots, **DO NOT** enter the initial configuration dialog. Just type “**No**” when you get a prompt with the following question:
 Would you like to enter the initial configuration dialog? [yes/no] : **No**

After you verify that the router is clean with no previous configurations, you may proceed to configure the router as follows:

HINT: You can find instructions on how to configure a Cisco router on the Cisco router configurations page.

- Configure a router name according to the network topology
- Disable ip domain lookup

- Configure IP addresses and enable gigabitEthernet 0/0 and gigabitEthernet 0/2
- Configure a static route
For r1, a static route to reach the 10.X.3.0/24 network via 10.X.2.2
For r2, a static route to reach the 10.X.1.0/24 network via 10.X.2.1

When you are done with the configurations, verify that both routers can ping all IP addresses below:

- 10.X.1.1
- 10.X.2.1
- 10.X.2.2
- 10.X.3.1

You have to troubleshoot and fix the problem if a router cannot ping all IP addresses.

If you look at the network topology, you can see that the DHCP server and the client are not in the same network. Therefore, you need a DHCP relay agent that forwards DHCP packets between the client and the server. **You will configure r2 as a DHCP relay agent** by using the `ip helper-address` command to enable a DHCP relay agent on a router interface connecting to the client network, as shown below.

Command	Description
r2> enable	Enable privileged EXEC mode
Router# configure terminal	Enter global configuration mode
Router(config)# interface gigabitEthernet 0/0	Enter gi0/0 interface configuration mode
Router(config-if)# ip helper-address 10.X.1.2	Enable a DHCP relay to a DHCP server that has IP 10.X.1.2

When you are done, call a lab assistant to verify that everything is correct. **You need approval from the lab assistant before you proceed!**

3.3 Configuring up the DHCP/DNS Servers

You should have already configured the DHCP and DNS services on the IK1203 VM (i.e., the server VM) on one of your laptops. The network adapter1 of the server VM should already be attached to a bridged adapter. You need to ensure that the bridged adapter is attached to your computer's Ethernet interface in the Name : section of the VM network settings.

Now, do the following:

- Launch the server VM on laptop1
- Once the server starts, check that the IP address, gateway, and DNS server are correctly configured.
- Launch Webmin, then start DHCP and DNS services via Webmin
- Verify that the server can ping all IP addresses of r1 and r2 (i.e., 10.X.1.1, 10.X.2.1, 10.X.2.2, 10.X.3.1)

After you verify that everything is ok. Call the lab assistant to verify your setup. **You need the lab assistant's approval before you proceed!**

3.4 Configuring the Web Server and the Client

In this part of the lab, you will configure the web server (www) and the client (clientY). We recommend configuring them simultaneously, with one student configuring the web server and the other configuring the client.

Configure the web server

You will use SSH to connect to either Host A (for Group nA) or Host B (for Group nB) of your group, following the instructions in Section 1.2 Accessing Devices in Networking Lab.

After you are connected to the host, you will do the following:

- Configure an IP address on eth1 (**DO NOT change eth0!**)

```
hostA:~$ sudo ip addr add 10.X.1.X/24 dev eth1
```

IMPORTANT: hostA:~\$ in the line above represents a terminal prompt of host A. It is not part of the command!

- Configure a default gateway

```
hostA:~$ sudo ip route add default via 10.X.1.1
```

- Verify that the IP address and default route are correctly configured

```
hostA:~$ ip addr          # check IP addresses
```

```
hostA:~$ ip route         # check the routing table
```

- Edit DNS information in the /etc/resolv.conf file. You can use a text editor such as vi or nano for editing, by either run "sudo vi /etc/resolv.conf" or "sudo nano /etc/resolv.conf". Then, edit the file so that it has two entries below for nameserver and search (replace X with your assigned number):

```
nameserver 10.X.1.2
```

```
search groupX.lab
```

- Verify that you can ping all IP address of routers and DNS server

- Verify that you can ping all routers and DNS server using names (e.g., r1.groupX.lab, r2.groupX.lab, ns.groupX.lab)

- Create a new HTML page

```
hostA:~$ echo "This is groupX" > index.html
```

```
hostA:~$ sudo mkdir -p /var/www/html
```

```
hostA:~$ sudo mv index.html /var/www/html/.
```

- Start a Web server application

```
hostA:~$ sudo service apache2 start
```

- Verify that the web server is running. The command below should show an apache2 process.

```
hostA:~$ ps aux|grep apache
```

- On the DNS server, launch Firefox and verify that you can access www.groupX.lab

Configure the client

If you use Host C (or Host D) as the client, you must use SSH to connect to Host C (or Host D) of your group, following the instructions on the Section 1.2 Accessing Devices in Networking Lab. Then, run a DHCP client process on **eth1** with a command:

```
hostC:~$ sudo dhclient eth1
```

After you run the DHCP client, make sure you verify the following:

- The client automatically receives an IP address and a default gateway from the DHCP server.
 - The client can ping all router IP addresses and the DNS server.
 - The client can ping all routers and a DNS server using names (e.g., r1.groupX.lab, r2.groupX.lab, ns.groupX.lab).
 - If the web server is configured, verify that the client can ping www.groupX.lab.
 - Launch Firefox and verify that the client can access `http://www.groupX.lab`.
- If you use Host C (or Host D), you can use a text-based web browser called w3m to access the web page by typing a command `w3m www.groupX.lab` on a terminal.
- If you cannot access the web page, you must troubleshoot and resolve the problem.

At this point, you can call a lab assistant to show that you have done everything correctly.

3.5 Assigning a Fixed-address via DHCP (Optional)

The DHCP server can assign a fixed IP address to a specific host using the host statement declaration. This is useful when you want to ensure that a specific host always has the same IP address. In this part of the lab, you will assign a fixed IP address to the web server based on its MAC address.

- On Host A, run either `ip addr` or `ip link` commands to check the web server eth1 MAC address
- On DHCP server, use Webmin to configure a fixed IP address for the web server (i.e., `10.X.1.X`) based on Host A's MAC address on eth1 by doing the following:
 - Launch Webmin and go to DHCP server configuration page
 - Click on the subnet `10.X.1.0`
 - Click on Add a new host (just below the Save button)
 - Fill in the following information:
 - Host description: `www`
 - Host name: `www`
 - Fixed IP address: `10.X.1.X` (X is your group number)
 - Hardware Address: `ether xx:xx:xx:xx:xx:xx`
(replace `xx:xx:xx:xx:xx:xx` with Host A's eth1 MAC address)

- Then, click Create
- You will be back on the Edit Subnet page, click Save.
- On the main DHCP server page, click Apply changes

On the web server (Host A), remove the eth1 IP address and the default route. Then, run a DHCP client and verify that the web server gets a correct IP address via the DHCP, by doing the following:

- Remove a default route

```
hostA:~$ sudo ip route del default via 10.X.1.1
```
- Remove the IP address on eth1

```
hostA:~$ sudo ip addr del 10.X.1.X/24 dev eth1
```
- Verify that the IP address on eth1 and default route is removed
- Run a DHCP client process on eth1 and verify that the web server gets a correct IP address and a default gateway.

```
hostA:~$ sudo dhclient eth1
hostA:~$ ip addr          # check IP addresses
hostA:~$ ip route         # check the routing table
```

After you verify that everything works correctly, you can call lab assistant to show your results.