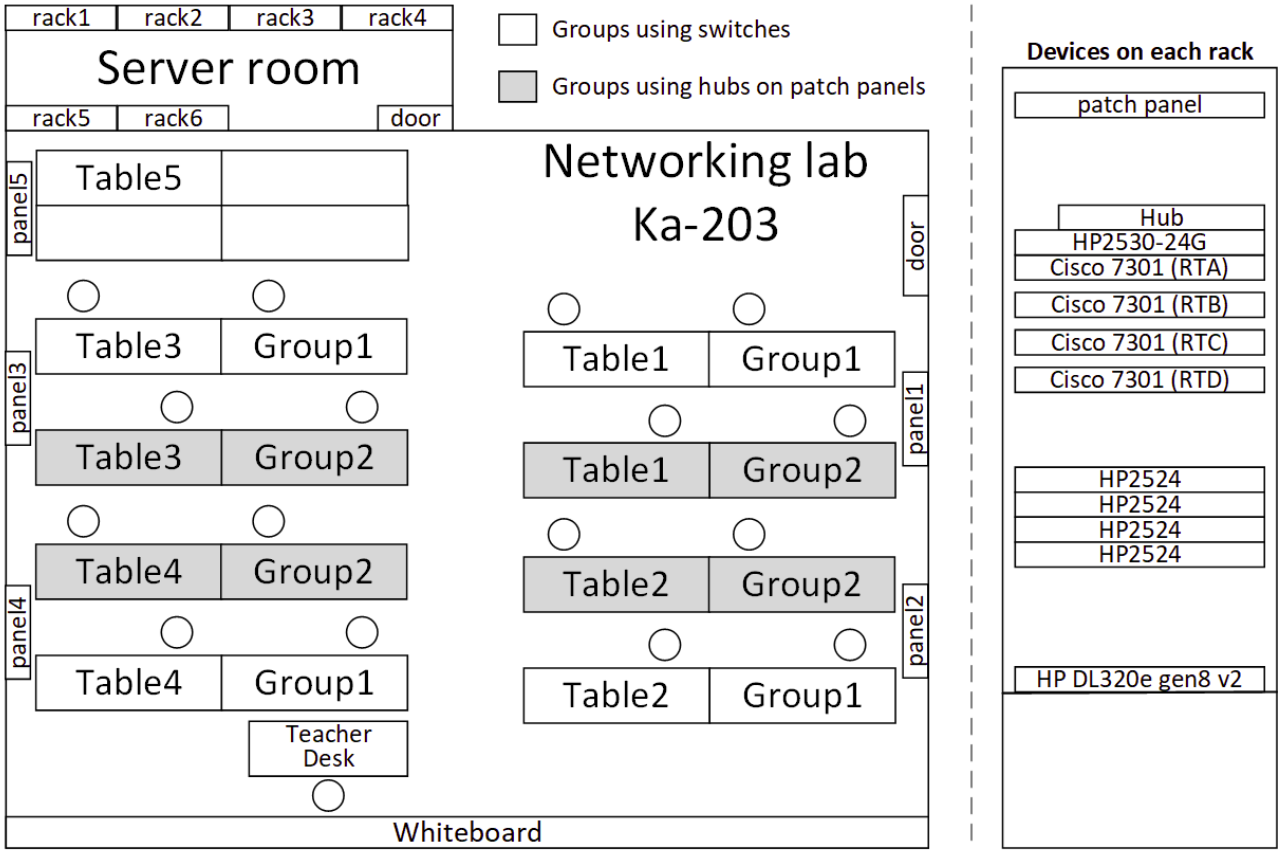
IK1203 Lab3

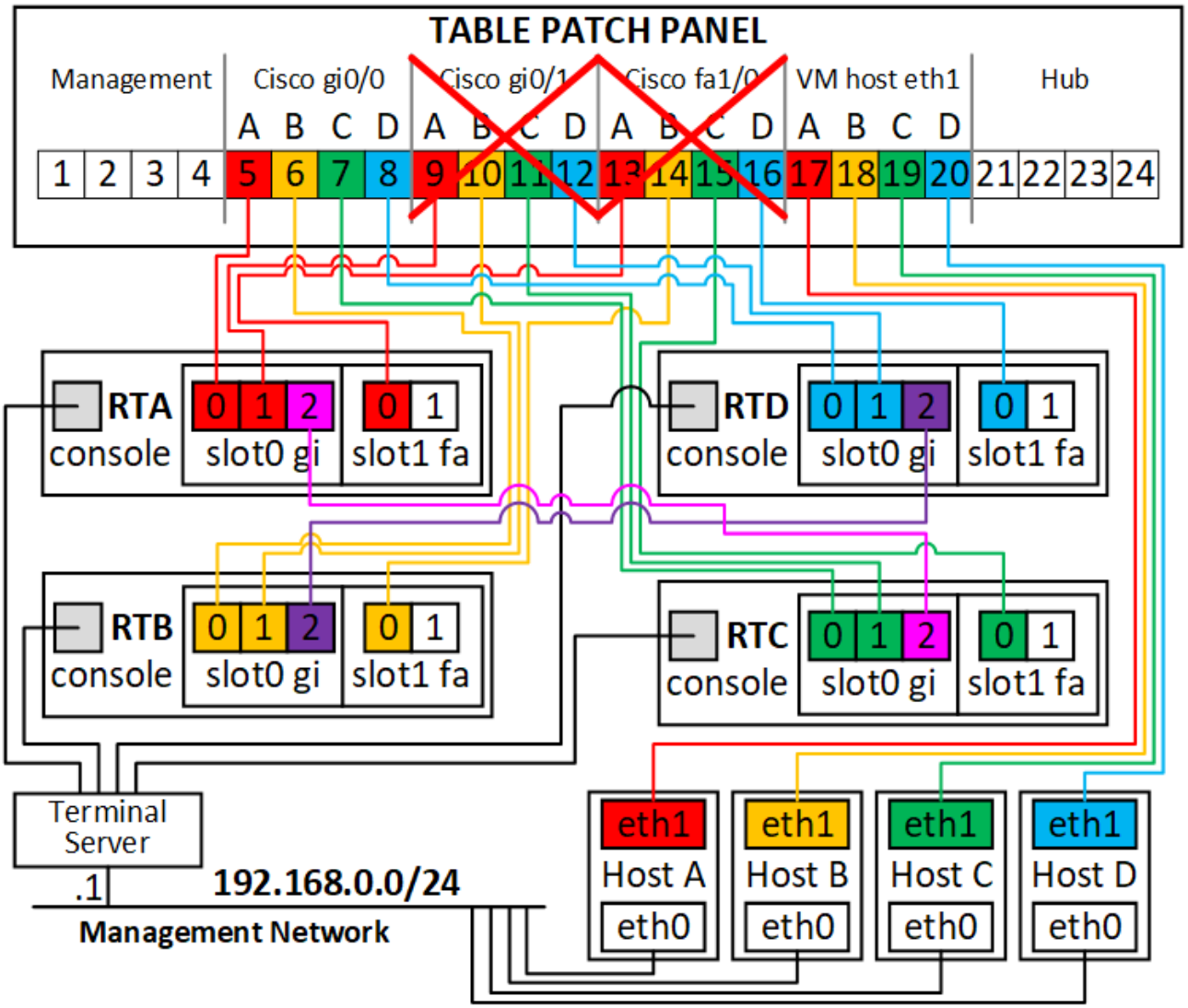
1.1 Networking Lab Infrastructure



There are five table groups in our networking lab, each with a patch panel connected to a rack located inside the server room, as shown in the figure below.Each rack has an identical setup with the following equipment.

- A patch panel that connects to the table in the working area.
- A hub used for sniffing traffic.
- A 1Gbps HP2530 switch that connects to the management network of the networking lab infrastructure (subnet 192.168.0.0/24).
- 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.

Each rack is already connected to the table patch panel according to the topology in the figure below. Throughout the lab session, students will sit and work in groups (two student pairs per table) at the first 4 tables (table1-4). Table 5 is reserved for the teaching staff's setup.
IMPORTANT: We limit the number of students to four students (i.e., two student pairs) per table, i.e., a maximum of 16 students per session.



X is the table number (1-4)
Y is the number (1-4) representing RTA-RTD in sequential order
Z is the number (1-4) representing Host A-D in sequential order
Router console access: SSH to 192.168.0.1 with port number: 2000 + (**X**-1)*4 + **Y**
Host access: SSH to host IP address: 192.168.0.**XZ**

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 networking 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 -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	Table1	Table2	Table3	Table4
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 table numbers, as shown below:

`ssh -Y student@192.168.0.x1` to access Table `x` host A.

`ssh -Y student@192.168.0.x2` to access Table `x` host B.

`ssh -Y student@192.168.0.x3` to access Table `x` host C.

`ssh -Y student@192.168.0.x4` to access Table `x` host D.

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

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

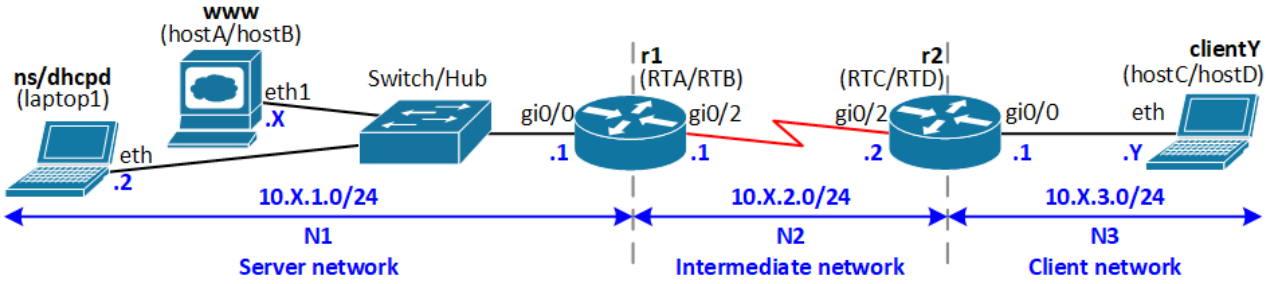
For Putty, Host Name (or IP address) should be the IP address given in the above commands, and the port number is 22.

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.

Device (student pair #1)	**Device (student pair #2)**	**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 (in the equipment box)	Hub on the patch panel	Switch/Hub
5 straight-through cables	5 straight-through cables	Twisted pair Ethernet cables

You can find cables and a switch nicely placed inside the lab equipment. **We expect you to roll the cables nicely and placed them back in the box at the end of the lab.**

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

After you are done connecting all cables, call the lab assistant to verify that everything is correct. **You need approval from the lab assistant 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 ***networklab***. The WiFi network is open, and you can join without any authentication. 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	Enable a DHCP relay to a DHCP server that has IP

10.X.1.2	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, you can proceed to the next section.

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 that you configure them simultaneously, one student configures the web server, and the other student configures the client.

Configure the web server

You will use SSH to connect to either Host A (for student pair #1) or Host B (for student pair #2) of your table following the instruction in Section 1.2 Accessing Devices in Networking Lab.

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

- Configure an IP address on eth1 **(DO NOT change eth0!)**
  ```
  hostA:~$ sudo ip addr add 10.X.1.X/24 dev eth1
  ```
- 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 laptop2 as a client, you will use the client VM for this purpose. Make sure that the bridged adapter is connected to the correct Ethernet interface on your laptop. Then, launch the client VM and use the network manager GUI to configure the `enp0s3` interface with the "Automatic (DHCP)" address assignment method.

If you use Host C (or Host D) as the client, you will need to use SSH to connect to Host C (or Host D) of your table following the instruction in 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 gets an IP address and a default gateway automatically from the DHCP server.
- The client can ping all routers IP addresses as well as 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 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: ethernet `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.