

Praktikum RouterLab SS 2009 Work Sheet 1: Introduction to the RouterLab

The RouterLab is a small network testbed that contains switches, routers, and load-generating Linux PCs (Loadgens). In this first worksheet we will get acquainted with its setup. The goal of this worksheet will be to configure IP addresses and static routes on routers and loadgens.

At the beginning of each work sheet, there will be a table that shows the assignment of devices (routers, switches, loadgens) and network address ranges to groups. You are ONLY allowed to access devices that have been assigned to you and that are reserved in your name in the reservation system. If not stated otherwise, you are ONLY allowed to use a device if the following three conditions hold:

1. The device is assigned to you according to the table at the beginning of the current work sheet.
2. The device has been reserved in the (*labtool*) reservation system.
3. The current time is within the reservation time slot that has been allocated to your group.

At the beginning of the semester, we have entered each group's reservations into the labtool reservation system. If you need extra time, it is your responsibility to reserve additional time on your assigned devices. Once you no longer need your devices, please end your reservation so that others may use the devices.

Table 1: Assignment of devices to groups

Group	A(Ham-Cloud)	B(Muc-Cloud)
Router	ham-rc1 , ham-rj1	muc-rc1, muc-rj1
Switches	ham-sc1	muc-sc1
IP range	10.1.0.0/16	10.2.0.0/16
Loadgens	loadgen102-ham	loadgen102-muc

Question 1: (5 Points) *Change your passwords*

You have already obtained passwords for the *RouterLab* giving you access to *cheetah*, *labtool*, and the routerlab web site. Your first task is to change your initial password for the *RouterLab*. To change your password, follow the appropriate link located on the *Routerlab* web site ¹.

<https://routerlab.net.t-labs.tu-berlin.de>

Question 2: (15 Points) *RouterLab topology*

Next, we need to get an overview of the topology of the RouterLab. For this purpose, please refer to the *User Information* on the routerlab website in particular the following sites:

- Wiki: <https://routerlab.net.t-labs.tu-berlin.de/trac/labtools/wiki/Routerlab>
- Devices: <https://routerlab.net.t-labs.tu-berlin.de/status.php>
- Links: <https://routerlab.net.t-labs.tu-berlin.de/links.php>

(a) Answer the following questions:

1. Which types of devices exist in the RouterLab?

¹Access to the website requires a Routerlab account and password

2. How many interfaces do your assigned routers (see Table 1) have and what are the interface names?
 3. What types of links exist in the RouterLab? Can you guess what the bandwidths of the links are?
- (b) The goal of this work sheet is to configure your devices such that packets can be sent from loadgen102-ham (Group B: loadgen102-muc) over ham-rj1 (muc-rj1) to ham-rc1 (muc-rc1) and vice-versa. The rest of this work sheet will guide you through the necessary steps.
- To begin, draw a topology map of the devices that you need to ensure IP connectivity between loadgen102-ham/loadgen102-muc and ham-rc1/muc-rc1. Figure out which interfaces you need and assign IP addresses. You are not allowed to use devices and IP addresses other than those specified in Table 1. Your topology map should show the assignment of IP addresses as well as the device and interface names!

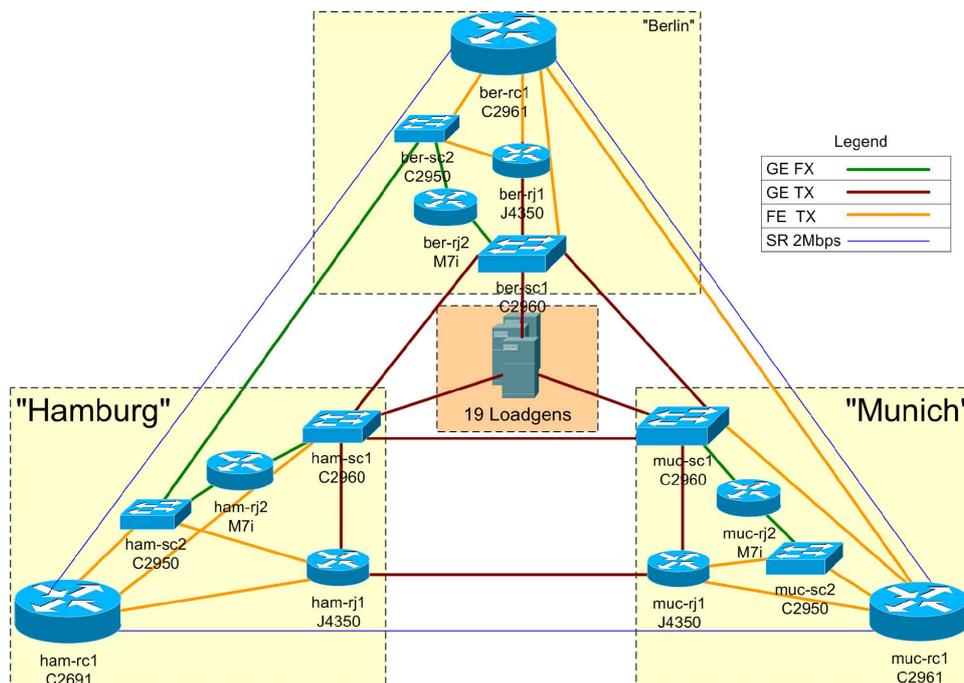


Figure 1: Setup of the RouterLab.

Question 3: (20 Points) Connecting to the devices

Now we will learn how to connect to the devices of the RouterLab. *cheetah* serves as a stepping stone for access to all devices. Therefore, you must always log on to *cheetah* using *ssh* before you can connect to any device. You can connect to *cheetah* using *ssh* from anywhere that you have Internet access by using the following command from a unix/linux/mac OS command line:

```
ssh <groupname>@cheetah.net.t-labs.tu-berlin.de
```

From there all devices can be accessed via a serial console terminal server while the *loadgens* may also be reachable with *ssh* depending on their network configuration.

Our console servers provide a number of serial ports that are connected to the serial ports of the *loadgens*, routers, and switches. The consoles of the connected devices can be accessed from *cheetah* by connecting to the console server with *Telnet*. The *labtool* simplifies this process however, as it maps the name of every device (e.g., *ham-rc1*) to the correct port of the console server. The following *labtool* command example demonstrates how to connect to the serial console of *ham-rc1* after logging on to *cheetah*:

```
lab -c ham-rc1
```

After pressing **Enter**, you are connected to the console of the appropriate device. In order to close the connection to a certain device from linux shell, you must type **Ctrl +]** and from windows ssh client **putty**, type **Ctrl + +**. This will get you to the command mode of Telnet, where you can then exit with **q** or **quit**.

- (a) Log on as root to `loadgen102-ham/loadgen102-muc` using `ssh`. No password is required for this. Read the *manpage* of `ifconfig`, the tool that is used on Linux to configure IP addresses and interfaces.²
1. How many physical interfaces are currently available on `loadgen102-ham/loadgen102-muc`? (Hint: Don't forget interfaces that are currently down!)
 2. Configure the IP address that you assigned to `loadgen102-ham/loadgen102-muc` in Question 2b to the appropriate interface.

- (b) `ham-rc1` (`muc-rc1`) runs the operating system Cisco IOS. In this course, we will mainly use the command line interface to configure routers. Cisco IOS distinguishes between modes where you can only display the current configuration of the device and modes where you can actually change the configuration. Get accustomed with the modes that exist in Cisco IOS by reading Section "Cisco IOS CLI Command Modes Overview" in the Cisco reference manual provided on the RouterLab course web site.

Draw a state diagram where nodes reflect the CISCO IOS modes and edges show the transitions from one mode into another. Consider only the following modes: *user EXEC mode*, *privileged EXEC mode*, *global configuration mode*, *interface configuration mode*.

A directed edge from mode *A* to mode *B* exists if there is a Cisco IOS command that allows you to directly switch from mode *A* to mode *B*. Label the directed edges with the required IOS commands. Label the nodes with the mode names and the characters that identify the node at the prompt.

Which Cisco IOS version is installed on `ham-rc1` (`muc-rc1`)? (Hint: Use "?" in *privileged EXEC mode* to find the appropriate command. You can use **TAB** key for command completion.)

- (c) `ham-rj1` (`muc-rj1`) uses JUNOS as operating system. To get accustomed with the modes on Juniper routers³, read the following pages of the Juniper reference manual provided on the RouterLab course web site: p217, p222, p228, p238-p240

Draw a state diagram similar to the one for the Cisco router. Consider the following states: *UNIX shell*, *CLI operational mode*, *CLI configuration mode (top-level)*, *CLI configuration mode (interfaces)*

(Hint: When you first log on to a router, you will be in *CLI operational mode* in most of the cases. Use `quit` to switch from *CLI operational mode* to a UNIX shell. To go back type `cli`.)

Which JUNOS version is installed on `ham-rj1` (`muc-rj1`)? (Hint: Use "?" in *CLI operational mode* to find the appropriate command)

The switches in the RouterLab use Cisco IOS as operating system, too. Therefore, the general handling of switches is similar to Cisco routers.

Question 4: (15 Points) *Reserving devices and dumping configurations*

The goal of this question is to familiarize you with the `labtool`. The `labtool` is the program that allows users to create and manage reservations for devices, and which allows users to save and load router and switch configurations.

- (a) Display the manual of the `labtool` by typing `lab -h` on `cheetah`. Find out which reservations are currently active. The device `ham-rj2` (Group B: `muc-rj2`) has not been reserved yet for you. Reserve this device for all your timeslots until April 30th. Note that you are not allowed to actually log on to this device throughout this work sheet!. Provide us the output of the `labtool` commands showing that this device is reserved by you.
- (b) Router and Switch Configurations can be saved either manually or via the `labtool`.

Manual Save: This is done by accessing the router, displaying the complete configuration of the router, marking the configuration text in your terminal window and pasting it to your

²use command `man ifconfig`

³you must login to juniper rj1 routers with `login:root, password:Router`

terminal window. To display the configuration on Cisco use `show running-config` in *privileged EXEC mode*, on Juniper use `show configuration` on the *CLI operational mode*. Manually dump the configuration of `ham-rc1/muc-rc1` and `ham-rj1/muc-rj1`! Check that there is no extra information copied to the file.

Labtool Save: Use the command `lab -cs` of the `labtool` to save the configuration of `ham-rj1 (muc-rj1)`. After a few seconds, the output of the `labtool` will show you the version number of the saved configuration. Confirm that your configuration has been saved into the `labtool` database by listing your recent configurations `lab -cl`.

- (c) Change the hostname of `ham-rc1/muc-rc1` and `ham-rj1/muc-rj1` to a random name, e.g., your first name! On Cisco use `?` in *global configuration mode* to find the appropriate command. On Juniper use the `set system host-name` command in the *configuration mode*. Use `write memory` on Cisco and `commit` on Juniper routers to save your new changes!!
- (d) Now we will restore the configuration that we saved in manual dump, for `ham-rc1` use the dump created with the `labtool`.

Reloading a manually generated dump: On Junipers use the command `load override terminal` in *CLI configuration mode*. Afterwards paste your configuration into your terminal window and then press `Ctrl + d`. Don't forget to commit your changes! (Note: On Cisco you don't need a special command. It's sufficient to just paste your configuration into the terminal window while being in *global configuration mode*.)

Checking the saved configuration: Use the command

```
lab --cx <reservation_id> <version> <device>
```

to export the content of the configuration you saved earlier. You can obtain the three necessary parameters by examining your configurations list with the `lab -cl` command.⁴

Reloading configuration with the Labtool: Use

```
lab --cd <reservation_id> <version> <device>
```

to reload the configuration for the Cisco router. For this you will need the version number that `lab -cl` provided in 4b. Open a connection to `ham-rc1 (muc-rc1)` before typing the `lab -cd` command. What do you see?

Question 5: (15 Points) IP address configuration on routers

We will now configure the IP addresses that you assigned in your topology map of Question 2.

- (a) Find out how IP addresses are configured on Cisco routers by using `?` in the appropriate *interface configuration mode*. Assign IP addresses to `ham-rc1/muc-rc1` according to your topology map. Use the following command:

```
ip address <ip address> <netmask>
```

- (b) Assign IP addresses to `ham-rj1/muc-rj1` according to your topology map. IPv4 addresses can be configured on Juniper routers with the following command:

```
edit interfaces <if-name> unit 0 family inet address <ip address>
```

Don't forget to use the `commit` command afterwards!

- (c) Find out how to delete IP addresses for Cisco and Juniper routers.
- (d) Ensure that the following pairs of devices can mutually reach each other (use `ping`):
 - `loadgen102-ham (loadgen102-muc)` and `ham-rj1 (muc-rj1)`
 - `ham-rj1 (muc-rj1)` and `ham-rc1 (muc-rc1)`

(Note: The `ping` command is available on Cisco and Juniper routers in *user EXEC mode / CLI configuration mode*.)

Question 6: (15 Points) Static routes

Recall that the goal of this work is to send packets from `loadgen102-ham` (Group B: `loadgen102-muc`) to `ham-rc1 (muc-rc1)` over `ham-rj1 (muc-rj1)` and vice-versa.

⁴We strongly recommend you to use either `labtool` or manual dumps to save configurations of your assigned devices. This will save a lot of time for you in setting up the devices

- (a) Check if ham-rc1 (muc-rc1) can reach loadgen102-ham (loadgen102-muc) using ping. Why does it not work?
- (b) Configure a static route on ham-rc1 (muc-rc1) to loadgen102-ham (loadgen102-muc) via next-hop ham-rj1 (muc-rj1).

Hint: Static routes on Cisco routers can be configured with the following command:

```
ip route <destination prefix> <destination mask> <next-hop>
```

- (c) Check if ICMP echo requests arrive at the appropriate interface of loadgen102-ham (loadgen102-muc). For this purpose use tcpdump on the appropriate interface of loadgen102-ham (loadgen102-muc). Do you see incoming packets? For more information on tcpdump we refer to the manpage.

Why does ping from ham-rc1 (muc-rc1) to loadgen102-ham (loadgen102-muc) not work yet?

- (d) Modify your setup such that loadgen102-ham (Group B: loadgen102-muc) can reach ham-rc1 (muc-rc1) and vice-versa. (Hint: Check the manpage of the commands route and ip)
- To verify that everything is correctly configured, also do a traceroute from loadgen102-ham (loadgen102-muc) to ham-rc1 (muc-rc1) and include the output in your answer.

Submission details: read the FAQ

http://www.net.t-labs.tu-berlin.de/teaching/ss09/RL_labcourse/faq.shtml

Submit the following:

- Topology map (in pdf format) with used routers, switches, *loadgens* and assigned IP addresses
- All configuration inputs on routers, switches and loadgens (no trials, only the final ones!)
- The outputs of all commands such as ping, tcpdump, etc.

Due Date: Friday, May 1st, 2009, 08:00 am⁵

⁵We will not accept any solutions submitted after this allowed time.