Exercise Series - Routing & DHCP

<mark>_Please consider the footnotes in the exercises!_</mark>

Exercise 1 Static Routing

Realize a router as an "embedded gateway" with Linux for the network assigned to you.
Use the pre-configured (nested) virtual machine (VM) "router" for this purpose.

1. Access the host VM / VMware ESXi using the web browser.

2. Now start the "router" VM and configure the router interfaces according to the guidelines[1] for
    your group:
    "ens192" → uplink
    "ens224" → servers
    "ens256" → clients
    See "S22.L2 – Lab Networks and Names" → "Routing and DHCP information".
    For the configuration you can use the administration tool "webmin".
    "webmin" is accessible on the respective VM (here "router" VM) using the address
    https://localhost:10000[2].
    Log in with the user "root" and familiarize yourself with the various setting options.

3. The network interfaces can be configured using
    "Networking → Network Configuration → Network Interfaces"
    Check if the three interfaces "ens192", "ens224", and "ens256" are displayed in the
    "Active Now" tab.
    Switch to the tab "Activated at Boot" and click on "ens192" to configure this interface.
    Now adjust the configuration[3] according to the specifications for your group and save the
    settings with (Save and Apply).
    Enter also the information for the IPv4 configuration of the interface "ens224" respectively
    "ens256" according to the guidelines and save them with (Save and Apply).

4. Now configure the "Default Route" of your router according to the guidelines.
    To do this, set the correct "Gateway" (interface "ens192") for your router under
    "Networking → Network Configuration → Routing and Gateways" in the
    "Boot time configuration" tab.
    To ensure that the "router" VM really forwards packets, set "Act as router?" to "yes".
    Save the settings you have made with (Save).

5. In order for your router to resolve other machines by name, you must next configure its DNS
    resolver.
    To do this, open "Networking → Network Configuration → Hostname and DNS Client".
    Enter the hostname "router" (if it is not entered automatically).
    Leave the entry at the "Resolution order" as it is[4].
    Now configure the "DNS Servers" with the IP addresses according to the guidelines for your
    group. Since your DNS server is not yet configured, you should enter the address of the
    laboratory DNS server 147.87.80.2 ("paris.bfh.ch") as the first address and only as the
    second address the one of your future DNS server (according to the guidelines).
    At "Search Domains" enter your forward domain/zone according to the guidelines.
    Save the settings you have made with (Save).

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[1]See "S22.L2 – Lab Networks and Names"
[2]Ignore the security warning and accept the insecure/self-signed certificate.
[3]You must enter a "Static configuration" with the correct specifications for "IPv4 address", "Netmask" and "Broadcast"
    for all router interfaces! You have to calculate "Netmask" and "Broadcast"!
[4]This sets the order of name resolution: local host file "/etc/hosts" and then DNS.

6. You should now be back on the "Networking → Network Configuration" page.
    Apply the configurations made by pressing (Apply Configuration).
    Applying the configuration takes some time, be patient, you may also see a popup window that
    the connection to https://localhost:10000 has been terminated. You can ignore this message, the
    connection should work again after restarting the interfaces.
    Your router should now be correctly configured and working.
    Test the internet connectivity of your router e.g. using "ping", "tracepath/traceroute", "mtr"[5]
    etc. e.g. "ping -4 www.switch.ch", "tracepath -4 www.switch.ch" or
    "mtr -4 www.switch.ch".
    Does a request (e.g. to "www.bfh.ch") work in the web browser of your router?
    Does the "router" VM work after a reboot?
    Trigger a reboot in the operating system ("ON/OFF" icon at the top right) or in "webmin" under
    "System → Bootup and Shutdown" using the button (Reboot System) (at the very bottom of
    the web page).

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[5]If "mtr" is not found you can install it with "sudo apt install mtr" (if your connection to the internet works).

Exercise 2 DHCP Server Configuration

Before the packet forwarding of the router can be tested, the DHCP server (on the "router" VM) must now be configured for the "clients" network according to the specifications for your group.

1. To do this, open "webmin" again.
   Under "Servers → DHCP Server" the DHCP server can be configured.

2. Start with the global client options, press (`Edit Client Options`).
   Configure here the options "Domain name", "DNS servers" with the domain and the DNS servers according to "S22.L2 – Lab Networks and Names" → "DNS information") for your group.
   Set the "Default lease time" and the "Maximum lease time" to small values (e.g. 200 and 300 secs) so that later on DHCP traffic is generated on your networks and you can record and analyze it with "wireshark".
   Set "Server is authoritative for all subnets?" to "Yes".
   Save the settings with (`Save`).

3. Restrict the DHCP communication to the interface "ens256" under
   (`Edit Network Interface`). Select the interface and click (`Save`).

4. Now add your "clients" subnet using "Add a new subnet":
   Enter as "Subnet description" e.g. "clients".
   Enter the "Network address" according to the guidelines for your "clients" network.
   Calculate the "Netmask" for your "clients" network and enter it.
   Enter the address range (DHCP scope) for your "clients" network under "Address ranges".
   Now create the subnet with (`Create`).

5. Now open the configuration for the subnet again (click on the subnet icon or the address).
   Afterwards you can edit the now existing subnet specific client options using
   (`Edit Client Options`).
   Enter the IP address of your router on the "clients" network (interface "ens256") under "Default routers". This will configure your router as the default router for systems that use DHCP on the "clients" network.
   Click (`Save`) to save the configuration and return to "Edit Subnet".
   Click (`Save`) to save the configuration and return to "DHCP Server".
   Now start the DHCP server with (`Start Server`).

6. Your DHCP server should start automatically after a reboot of the router.
   Configure this under "System → Bootup and Shutdown".
   In the "Service name" column, check the box at "isc-dhcp-server".
   Click at the bottom (`Start On Boot`).
   Go back to the "Bootup and Shutdown" page and verify that the "dhcpd.service" is set to "Yes" in the "Start at boot?" column.
   This also completes the configuration of the DHCP service.

Exercise 3 Testing Router and DHCP

The purpose of this exercise is to check whether the router and the DHCP service are working correctly. In addition, the DHCP communication should be recorded and analyzed using "wireshark". At the end of the exercise, your networks should work according to the guidelines and the systems should be able to communicate with each other and with the Internet.
If this is not the case, try to find out systemically with the tools at your disposal (e.g. "ping", "tracepath"/"traceroute", "wireshark") what the reason could be.
If you do not find the causes yourself, contact the lecturer.

1. Start "wireshark" on the router in a "root" terminal:
    "Applications → Internet → Wireshark Network Analyzer".
    Sniff the network traffic on the interface "ens256".

2. Now start the Windows 10 Client VM "client02"and log in.

3. Open a command window: click the "Start" button and type "cmd" in the search field, press the <RETURN> key, a command window should open.
    Enter the command "ipconfig /all" in the command window.
    Check the interface configuration of the Ethernet adapter. Do they match the DHCP server settings for the "clients" network?
    If not, try to correct the settings of the DHCP server.

4. Try to connect to a computer on the Internet (e.g. using "ping www.google.com").
    Does your client computer has Internet connectivity?
    If not, try to find out why this does not work[6].

5. Now release the DHCP configuration on the client with the command
    "ipconfig /release" voluntarily. This should also cause the client to lose Internet connectivity.
    Fetch a new DHCP configuration on the client with the command "ipconfig /renew" and look at it. Does the client has connectivity again?

6. Analyze the capture made by "wireshark" regarding:
    DHCP (filtering for "bootp" or "dhcp")
    ARP (filtering for "arp")
    ICMP (filtering for "icmp")
    Does this communication behave according to expectations and as learned in class?

7. Sniff the traffic on the router's "uplink" interface "ens192" while surfing the Internet from a client and analyze it.

We will test the correct function of the "servers" network in the next series of exercises "DNS & WWW" in exercise 1 point 6.

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[6]If necessary, with the assistance of the lecturer.