

# Lab 1.1. IPv4 and DHCP

## Objectives

This lab introduces the tools to be used in this subject, briefly reviews basic aspects of IPv4, and analyzes the characteristics of DHCP.

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## Lab Preparation

We will configure the network topology shown in Figure 1. All the elements -the router and the virtual machines (VM)- are linked clones of the base machine ASOR-FE. The configuration of VMs is done with the vtopol utility:

1. Define the base VM:

```
$ asorregenerate
```

This command creates a new VM (ASOR-FE) in VirtualBox. ASOR-FE is the base image for all network elements used in these labs.

**NOTE:** If the previous command doesn't work, try to delete the VirtualBox folder with the VMs.

2. Create file pr1.topol with the network topology, composed of 4 VMs and 2 networks. File content is:

```
netprefix inet
machine 1 0 0
machine 2 0 0
machine 3 0 0 1 1
machine 4 0 1
```

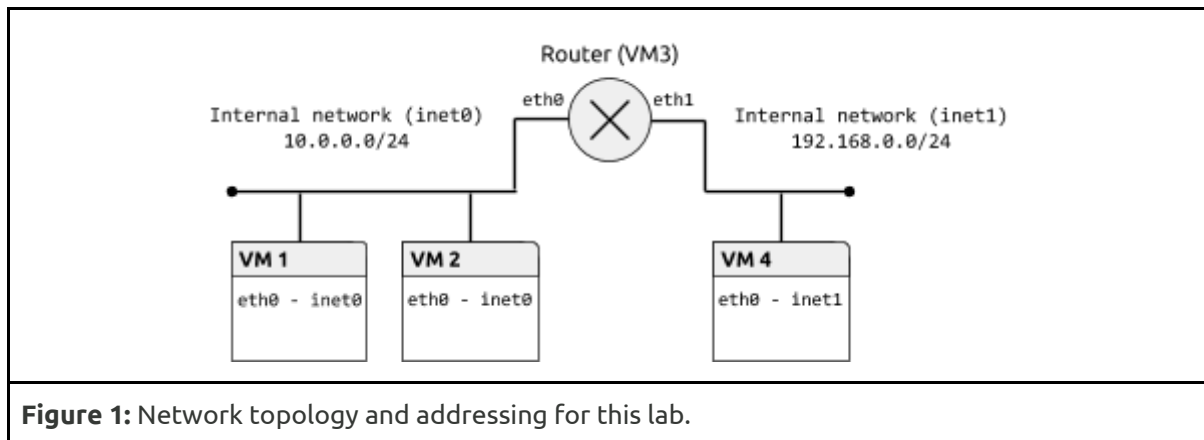
Syntax is:

```
machine <VM number> <interface0> <network0> ...
```

3. Create the network topology that will boot four VMs (VM1, VM2, Router and VM4).

```
$ vtopol pr1.topol
```

In VirtualBox, the VMs asorfemachine\_1 (VM1), asorfemachine\_2 (VM2), asorfemachine\_3 (Router - VM3) and asorfemachine\_4 (VM4) will be defined.




**NOTE:** Log in to any VM with user “cursoredes” and password “cursoredes”.

## Static Configuration

First, we will statically configure each network segment, 10.0.0.0/24 and 192.168.0.0/24, by assigning an appropriate IP address to each network interface on each VM.

**Exercise 1 [VM1].** Determine the network interfaces available in the VM and the IP and/or MAC address assigned to it. Use the `ip` command. 


**Exercise 2 [VM1, VM2, Router].** Enable `eth0` in VM1, VM2 and Router, and assign an appropriate IP address. Use the `ip` command, in particular, commands `ip address` and `ip link`. 

**Exercise 3 [VM1, VM2].** Start wireshark and start packet capture in the network interface. Check the connectivity between VM1 and VM2 with `ping`. Analyze the generated traffic, specially the encapsulated protocols in each datagram and the source and destination addresses.

Complete the following table for all messages exchanged until the reception of the first Echo Reply.

- Write important characteristics (e.g. ARP request/reply or ICMP type) in “Message type”.
- Compare observed data with the format of messages studied in class.

Source MAC	Dest. MAC	Protocol	Source IP	Dest. IP	Message type
02:00:00:00:01:00	Bcast	arp	10.0.0.1		
02:00:00:00:02:00	02:00:00:00:01:00	arp	10.0.0.2	10.0.0.1	
		icmp	10.0.0.1	10.0.0.2	echo request
02:00:00:00:03:00	02:00:00:00:01:00	arp		10.0.0.1	

**Exercise 4 [VM1, VM2].** Execute again the `ping` command between VM1 and VM2, and then check the status of the ARP table in VM1 and VM2 using the `ip neigh` command. The meaning of the state of each table entry can be found in the man page of the command. 

**Exercise 5 [Router, VM4].** Configure the network segment 192.168.0.0/24. Check connectivity

between Router and VM4, and between Router, VM1 and VM2.



## Static Routing

According to the topology, Router can route traffic between networks 10.0.0.0/24 and 192.168.0.0/24. In this section, we are going to configure the static routing, based on manually configured routes in all VMs.

**Exercise 1 [Router].** Enable packet forwarding in Router, so that it can actually work as a router. Execute the following command:

```
# sysctl net.ipv4.ip_forward=1
```

**Exercise 2 [VM1,VM2].** Add Router as the default router for VM1 and VM2. Use the `ip route` command.



**Exercise 3 [VM4].** Even if the appropriate configuration for the route table in networks like this involves adding default routers, it is also possible to include routes for specific networks. Add to the route table of VM4 a route to network 10.0.0.0/24 via Router.



**Exercise 4 [VM1,VM4].** Use the `ping` command between VM1 and VM4. Using Wireshark, complete the following table for all interchanged packets until the reception of the first Echo Reply.

borrar tabla arp: `sudo ip n flush dev eth0`

### Network 10.0.0.0/24 - VM1

Source MAC	Dest. MAC	Protocol	Source IP	Dest. IP	Message type
02:00:00:00:01:00	bcast	arp	10.0.0.1	10.0.0.3	
02:00:00:00:03:00	02:00:00:00:01:00	arp	10.0.0.3	10.0.0.1	
		icmp	10.0.0.1	192.168.0.2	echo request
		icmp	192.168.0.2	10.0.0.1	

### Network 192.168.0.0/24 - VM4

Source MAC	Dest. MAC	Protocol	Source IP	Dest. IP	Message type
		icmp	10.0.0.1	192.168.0.2	echo request
02:00:00:00:04:00	bcast	arp	192.168.0.1	192.168.0.2	
02:00:00:00:03:01	02:00:00:00:04:00	arp	192.168.0.2	192.168.0.1	

## Dynamic Configuration

DHCP allows administrators to dynamically configure network parameters of a host. In this section, we will configure Router as a DHCP server for both networks. Although DHCP can include a lot of

configuration parameters, in this lab we will only set the default router.

**Exercise 1 [VM1, VM2, VM4].** Remove IP addresses from the network interfaces (`ip addr del`).

**Exercise 2 [Router].** Configure DHCP server for both networks:

- Edit `/etc/dhcp/dhcpd.conf` file and add two subnet sections, one for each network, defining address ranges `10.0.0.50-10.0.0.100` and `192.168.0.50-192.168.0.100`, respectively. Also, add option routers with the IP address of the default router on each network. Example:

```
subnet 10.0.0.0 netmask 255.255.255.0 {  
    range 10.0.0.11 10.0.0.50;  
    option routers 10.0.0.3;  
    option broadcast-address 10.0.0.255;  
}
```

- Start the service with command `service dhcpd start`.

**Exercise 3 [Router, VM1].** Start packet capture in Router. Start a DHCP client (with command `dhclient -d eth0`) in VM1 and observe the configuration process. Complete the following table:

**DHCP messages interchanged during the configuration**

Source IP	Destination IP	DHCP message	DHCP options

**Exercise 4 [VM4].** During system boot up it is possible to automatically configure some interfaces according to the information stored on disk. Check file `/etc/network/interfaces` in VM4, which automatically configures interface `eth0` using DHCP. For more information, check file `/usr/share/doc/initscripts-*/sysconfig.txt`.

**Exercise 5 [VM4].** Check the automatic configuration with `ifup` and `ifdown` commands. Check connectivity between all VMs in both networks.