Communication Protocols
2021-2022

Lab Assignment 1 – Dynamic Host Configuration Protocol

Objectives and organisation

The objective of this lab assignment is to explore the configuration and use of Dynamic Host Configuration Protocol (DHCP). DHCP is an extremely important topic in current networks, as it is at the basis of auto-configuration.

The assignment can be prepared using the GNS3 router emulator before executing it in the lab. There are guided exercises, for which the commands/actions to execute are presented and explained, and proposed exercises that should be done autonomously by the students.

The following topics are addressed in the lab assignment:

- Configuration and use of DHCP in Cisco-based networks

Throughout the execution of the lab assignment, commands output and configuration files should be kept for inspection by the teacher. Special attention should be given to their interpretation and explanation.

The current lab assignment may require cooperation between groups in order to setup the scenarios under study. More than the sheer configuration of individual routers, it is important to interpret, explain and understand the behaviour in the overall network scenario. This is a key element for evaluation.

The following aspects will be taken into account when evaluating the work:

- Preparation of the lab assignment – 10%
- Knowledge of the aspects under consideration – 30%
- Exercises execution – 50%
- Group autonomy – 10%

1. Dynamic Host Configuration Protocol

The DHCP protocol is used in order to allow hosts to automatically obtain their basic configuration information from a server. DHCP is defined in RFC 2131.

Typical configuration parameters obtained through DHCP are IP address, network mask, default gateway and DNS server. Nevertheless, several other options can be configured through DHCP, such as domain name, NTP servers, time zone, etc.. The various configurable options are defined in RFC 2132.

DHCP recognises three types of machines: clients, servers and proxies.

Client machines obtain configuration information from a server. Client requests are broadcasted, using UDP, and contain the list of requested options.

Servers listen to client requests and send replies with the requested configuration information, if existent. There can be more than one DHCP server per network, for redundancy reasons.

In case clients and servers are not in the same network, a proxy must be used to forward client requests to the servers and to relay the respective replies. Typically, proxies are routers.

Cisco IOS version 12.0 and later versions include DHCP functionality, meaning that Cisco routers can take up the role of DHCP servers/proxies, thus eliminating the need for dedicated systems.

One important DHCP feature is the possibility to specify a lifetime for the assigned parameters. This is known as 'lease time'. If a client wants to keep its DHCP-assigned IP address longer than the defined lease time, it must renew its request before it expires.

The IP addresses assigned by DHCP can be dynamically chosen from one or more predefined address ranges, or there may be a fixed correspondence between MAC addresses and IP addresses so that specific clients always get the same IP address.

1.1 Basic DHCP configuration of a Cisco router

Analyse the following Cisco router configuration example, in which the router is configured to act as a DHCP server, assigning IP addresses in a dynamic way.

```
R1#config t
R1(config)#service dhcp
R1(config)#ip dhcp pool DEMO
R1(dhcp-config)#network 172.16.1.0 255.255.255.0
R1(dhcp-config)#default-router 172.16.1.1
R1(dhcp-config)#exit
R1(config)#ip dhcp excluded-address 172.16.1.1 172.16.1.30
R1(config)#ip dhcp excluded-address 172.16.1.220 172.16.1.255
R1(config)#end
R1#
```

The 'ip dhcp pool' command is used to assign a name to the address pool that is going to be defined and to enter the pool's configuration mode. The pool's address range is defined using the 'network' command. Next, the address of the default router to be used by the clients is defined. Lastly, two address ranges are excluded from the pool, using the 'ip dhcp excluded-address' command.

Exercise 1 – Based on the previous example, configure your router so that it acts as DHCP server for your local area network, according to the scenario presented in Figure 1. The configuration should comply with the following:

- Ask the teacher the values of the X and N variables, where N is the number of your group.
- The address of your local area network must be 192.168.X.0/24.
- The router's Ethernet0 interface should have 192.168.X.254 as IP address, and should be connected to your local network, to which the DHCP client machines should also be connected. If you do not want to use a switch you can directly connect your computer to the router using a crossover cable.
- Define the address pool, which should comprise the whole 192.168.X.0/24 network. The name of the pool should be GROUP-N (replace N by the number of your group).
- Define the default router.
- Consider that the addresses from .1 to .31 and from .224 to 254 are reserved for fixed address assignment.
- Configure your computer so that it automatically obtains the network configuration and connect it to your local network (i.e., to your router, using a crossover cable).
- Check the connectivity to your router, using the ping command.
- Which IP address did your computer obtain?
- Check the DHCP table in your router, using the 'show ip dhcp binding' command. Explain the contents of this table, noting the IP addresses, MAC addresses, lease times and types.

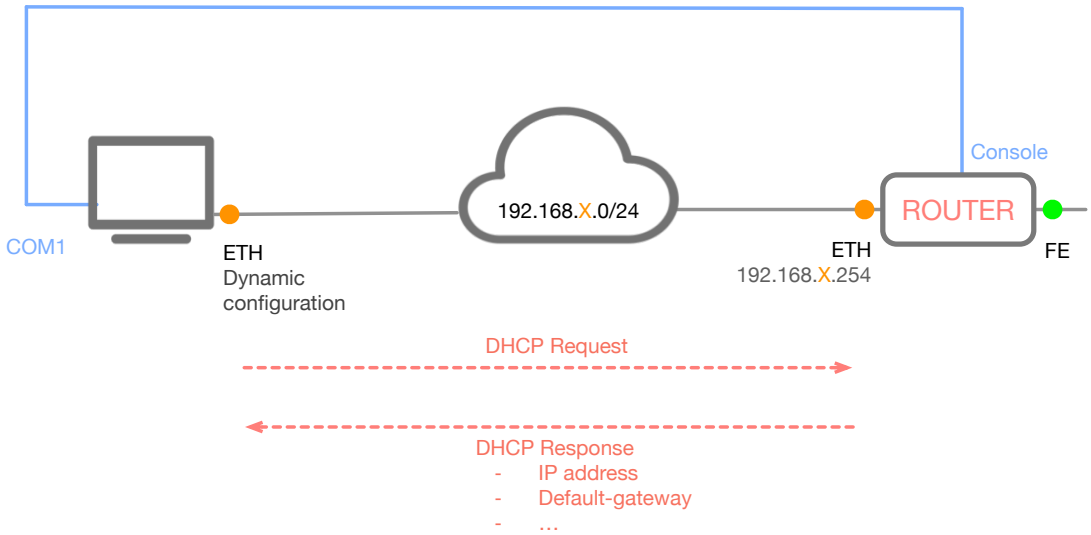

Figura 1 – Basic DHCP scenario

NOTES:

- Bear in mind that your computer should be configured so as to automatically obtain the network configuration (i.e., it should be configured to use DHCP).
- In order to see the network configuration of your computer open a command prompt window and type the following command:
  - ipconfig /all

- In order to renew the network configuration of your computer, type the following commands:
  - ipconfig /release
  - ipconfig /renew

In addition to defining the default router, many other options can be defined. RFC 2132 identifies these options by assigning them a unique number. In order to ease their configuration, Cisco routers allow these options also to be identified by a name. The following table presents the correspondence between Cisco names and RFC 2132 option numbers.

Table 1 – Correspondence between Cisco DHCP option names and RFC 2132 option numbers

DHCP name	Option number
client-name	option 12
default-router	option 3
domain-name	option 15
dns-server	option 6
netbios-name-server	option 44
netbios-node-type	option 46
lease	option 58
host	option 1

In the configuration commands, option names or number can be used interchangeably. Thus, command

```
R1(dhcp-config)#default-router 172.16.1.1
```

Is equivalent to

```
R1(dhcp-config)#option 3 ip 172.16.1.1
```

If you want to define a primary DNS server and one or more secondary servers, you should provide the address of the primary followed by the addresses of the secondary servers. For instance

```
R1(dhcp-config)#dns-server 172.16.1.1 192.168.100.200
```

Find the way to define a NetBIOS (WINS) name server, by entering '?'.

Exercise 2 – Add the following options to the previous DHCP server configuration:

- DNS servers. Assume that the primary DNS server has address .31 in your network. Specify a secondary DNS server with address 10.254.0.252.
- Specify your domain name as net-N.dei.uc.pt.
- Specify a NetBIOS (WINS) name server that should use the 10.1.0.253 IP address.

1.2 Lease time

The definition of a lease time (or lease period or, simply, lease) for the IP addresses assigned by a DHCP server can be done using the 'lease' command. In the following example a lease time of 2 days, 6 hours and 30 minutes is specified.

```
R1(dhcp-config)#lease 2 6 30
```

If no lease time is defined, the IP address assignment has a lifetime of 1 day, i.e., this is equivalent to

```
R1(dhcp-config)#lease 1
```

(note that it is not necessary to write 'lease 1 0 0 ', as the hour and minute parameters are optional)

Exercise 3 – Execute the following:

- Define a lease time of 2 minutes, so that the activity of the DHCP protocol is quite frequent.
- Force the DHCP client to obtain a new network configuration (which will include the new lease time) and check that the lease time obtained by the client corresponds to what you specified in the server.
- Run the commands 'debug ip dhcp server event' and 'debug ip dhcp server packet'. Analyze and interpret the results.
- Check the statistics of your DHCP server, by executing the command 'show ip dhcp server statistics'. Analyze and interpret the results.

1.3 Static address assignment

It is possible to configure the DHCP server in such a way that it assigns the same IP address to a particular host. To do so, the 'host', 'client-identifier' and 'client-name' options should be used. In the following example, the IP address 172.31.1.34 is always assigned to the machine with MAC address 0001.0385.47a2 (note that the hexadecimal characters 01 are added to the front of the MAC address). This machine has the relative name 'socrates' in domain 'gvrn.com'.

```
R1(config)#ip dhcp pool SOC
R1(dhcp-config)#host 172.31.1.34 255.255.255.0
R1(dhcp-config)#client-identifier 0100.0103.8547.a2
R1(dhcp-config)#client-name socrates
R1(dhcp-config)#default-router 172.31.1.1
R1(dhcp-config)#domain-name gvrn.com
R1(dhcp-config)#dns-server 172.31.1.2
R1(config)#end
R1#
```

Please note that this type of assignment must be done in a separate pool, that is, it cannot be done in the basic DHCP server pool containing a 'network' command.

Exercise 4 – Execute the following:

- Configure the server so that it assigns a fixed IP address to your computer. The chosen IP address should be consistent with your previous configuration and, thus, should not belong to the dynamic assignment address range.
- Use the command 'show ip dhcp binding' to check the assigned addressed and the respective lease. Subsequently, clear the DHCP binding table using the flowing command: 'clear ip dhcp binding * '. What happened to the fixed address assigned that you just defined? Explain why.
- Force the computer to obtain a new network configuration. What's the IP address obtained by the computer? Does it correspond to what you have specified?