Public WLAN

I. Objectives

The objectives of this practical work are:

1. Understand how a public WLAN infrastructure can be setup
2. Understand how DHCP and DNS
3. Verify the operation of a captive portal
4. Verify how performance throttling works
5. Usage of virtual machines and their interconnection with other virtual/physical links

II. Introduction

This execution of practical work will guide through the setup, configuration and usage of a Captive Portal to control a Firewall, which provides access to external networks. pfSense provides a free implementation of two components. To emulate a WLAN hotspot an Access Point, implemented by a Fiber Gateway, will be used.

a. Duration

This work is expected to take one class, practical component (1h15)

b. Equipment

This work will use, per group:

1) 1x Fiber Gateway (AP)
2) 1x laboratory PC, with Linux (Ubuntu)
3) 1x student terminal with WLAN/802.11 interface
4) 2x Virtual Machines (VM) to:
    a. Run pfSense Server
    b. Run a configuration machine, in the management network

c. Network diagram

Your laboratory PC already has VirtualBox installed and you will find two VM in the Desktop.

The first VM (‘pfSense Server’) is already installed with pfSense that implements a Firewall controlled by a Captive Portal, often used to control access to Internet when connect to in public and private spaces hotspots via WLAN accesses. A second VM (‘pfSense Config’) is used to access the pfSense configuration web page via an internal VirtualBox network (‘Vboxnet0’).

The pfSense Server connects (Adaptor 3, bridged to an ethernet interface of the lab PC) to an AP (implemented by a Fiber Gateway), providing controlled access (via Adaptor 1, also bridged to an ethernet interface of the lab PC) to external networks (e.g. Internet).

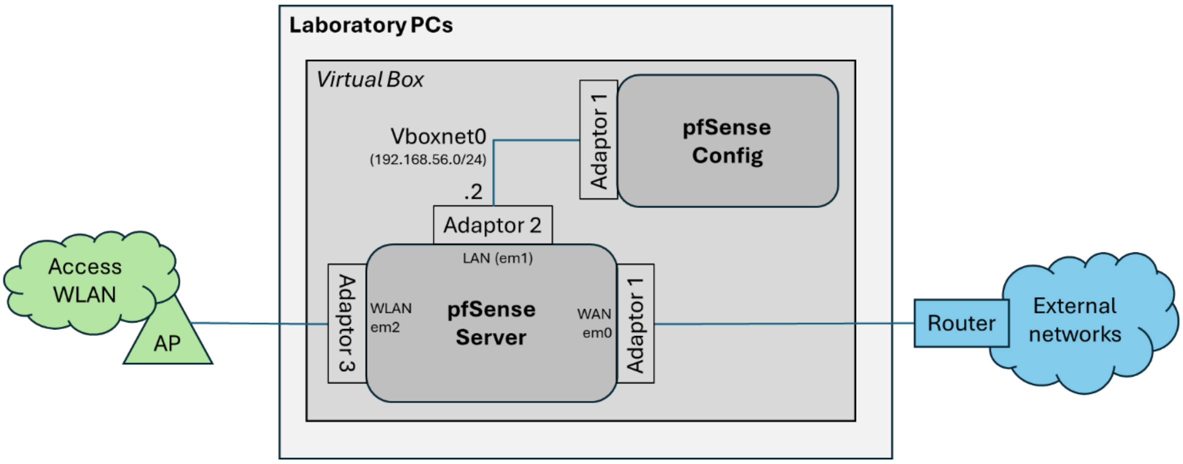


Figure 1: Reference network diagram

When connecting your WLAN devices to the AP, you shall get the following configuration:

a) *IP Address: 192.168.57.0/24*
b) *Gateway: 192.168.57.2*
c) *DNS Servers: 192.136.xx.xx*

The pfSense Config VM shall get the following configuration:

a) *IP Address: 192.168.56.0/24*
b) *Gateway: 192.168.56.2*

To carry out the tests, use the following users in the Captive Portal:

Users	**Pass.**	**Speed (kbps)**	**Time (s)**	**Volume (MB)**	**Associated test URL**
cm	cm	unlimited	unlimited	unlimited	https://www.nperf.com/en/
cm_band	cm	1024/128	unlimited	unlimited	https://www.nperf.com/en/
cm_time	cm	unlimited	2 min	unlimited	any
cm_traffic	cm	unlimited	unlimited	64	https://www.gns3.com/software/download-vm

Table 1: Configured test users

For more information on pfSense, use the URL links in ‘References’ section, at the end.

III. Initial physical network setup

1. Get one Ethernet USB Adapter and an Ethernet cable from the laboratory
2. Connect the USB Ethernet Adapter to a blue USB port in the back of the Lab PC

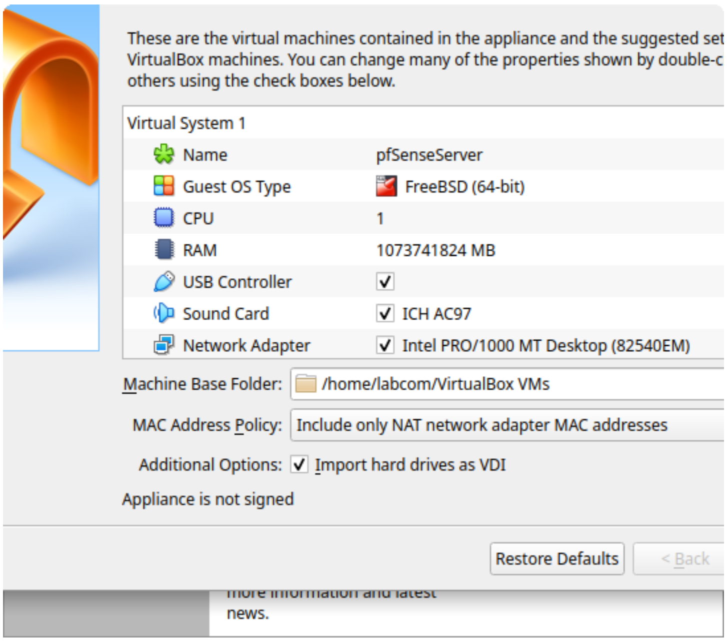
3. Open a 'Terminal Emulator' in the Lab PC and run the command 'ifconfig'
   - A new ethernet interface named 'enx*MMMMMMMMMMMM*' shall be present, where '*MMMMMMMMMMMM*' is the MAC address of this interface (compare it with the 'ether' field)
4. Switch on the Fiber Gateway

IV. pfSenseServer VM VirtualBox installation

5. In your lab PC Desktop, check the existence of two .ova files corresponding to the two VMs you are going to use in this practical exercise:
   a) *pfSenseServer.ova*: image of the VM that will run the pfSense server, central piece of the experiment you going to carry out;
   b) *pfSenseConfig.ova*: image of the auxiliary VM that will be used to access the pfSense server configuration and status.

Figure 2: VM images to be used

6. Double click in the 'pfSenseServer.ova' VM image; VirtualBox (VBox) shall start with the following window (Figure 3); press 'Import'.



These are the virtual machines contained in the appliance and the suggested set
VirtualBox machines. You can change many of the properties shown by double-c
others using the check boxes below.

Virtual System 1

Name	pfSenseServer
Guest OS Type	FreeBSD (64-bit)
CPU	1
RAM	1073741824 MB
USB Controller	☑
Sound Card	☑ ICH AC97
Network Adapter	☑ Intel PRO/1000 MT Desktop (82540EM)

Machine Base Folder: /home/labcom/VirtualBox VMs

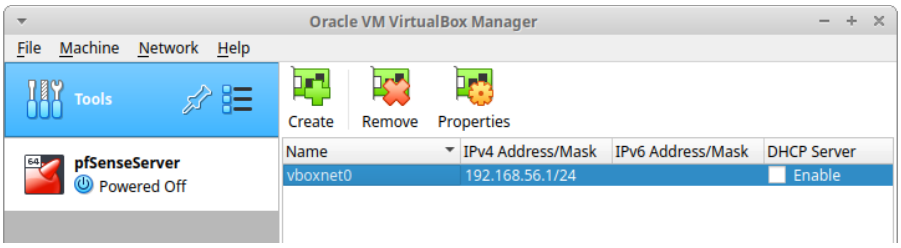
MAC Address Policy: Include only NAT network adapter MAC addresses

Additional Options: ☑ Import hard drives as VDI

Appliance is not signed

*Figure 3: **Virtualbox Config***

7. When finished, in VBox 'Tools', select 'Network'
   a) If there any network configured, 'Remove' it;
   b) 'Create' a new network (shall be named 'vboxnet0' automatically) and unselect 'DHCP' server; *IP addresses will assigned by the pfSense server*;
   c) Take note of the IP network associated to this VBox internal network.

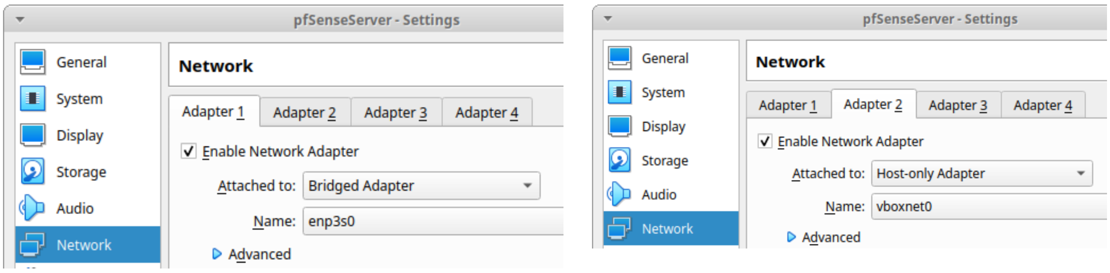


Name	IPv4 Address/Mask	IPv6 Address/Mask	DHCP Server
vboxnet0	192.168.56.1/24		☐ Enable

Figure 4: VirtualBox internal network creation

8. Go to the ‘Settings’ of the recently created VM (‘pfSenseServer’) and select ‘Network’

    a) Check where ‘Adapter 1’ and ‘2’ are ‘Attached to’ and the respective ‘Name’.



Adapter 1: ☑ Enable Network Adapter
Attached to: Bridged Adapter
Name: enp3s0

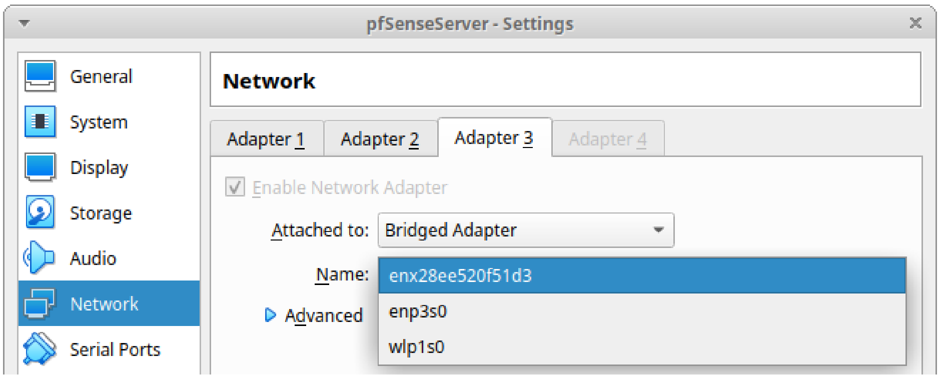
Adapter 2: ☑ Enable Network Adapter
Attached to: Host-only Adapter
Name: vboxnet0

Figure 5: pfSenseServer Adaptors configuration (i)

    b) Go to ‘Adapter3’:

        i. As with ‘Adapter 1’, it shall be of type ‘Bridged Adapter’;

        ii. Go to the ‘Name’ drop down menu and select the Ethernet USB Adapter will plugged in step 2; it shall be named ‘enxMMMMMMMMMMMM’, in line with what you saw in step 3.

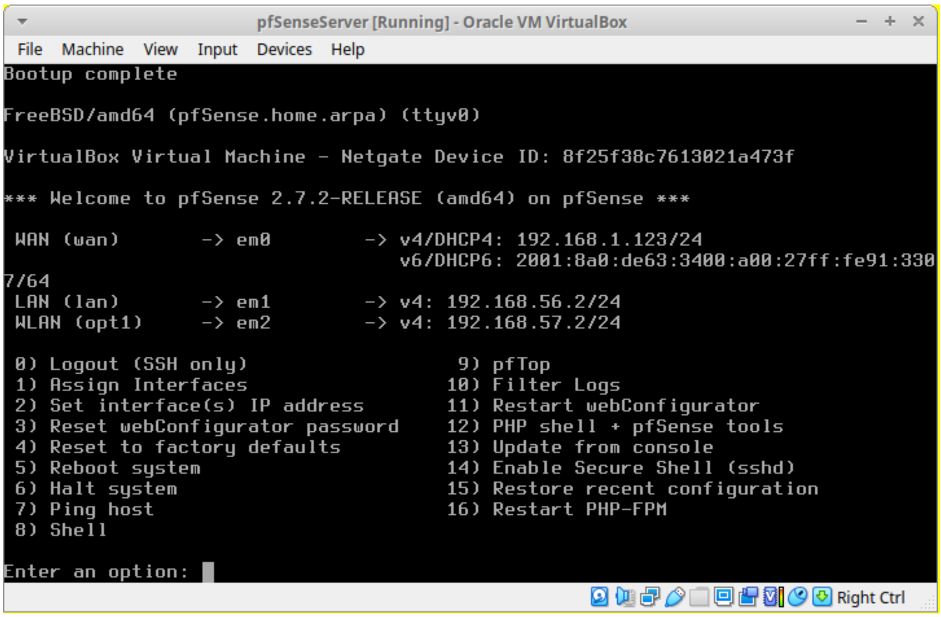


Adapter 3: ☑ Enable Network Adapter
Attached to: Bridged Adapter
Name: enx28ee520f51d3
enp3s0
wlp1s0

Figure 6: pfSenseServer Adaptors configuration (ii)

        iii. Press ‘OK’

9. Start the ‘pfSenseServer’ VM; when finished, you shall see the following screen.



```
Bootup complete

FreeBSD/amd64 (pfSense.home.arpa) (ttyv0)

VirtualBox Virtual Machine - Netgate Device ID: 8f25f38c7613021a473f

*** Welcome to pfSense 2.7.2-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0        -> v4/DHCP4: 192.168.1.123/24
                                  v6/DHCP6: 2001:8a0:de63:3400:a00:27ff:fe91:330
7/64
 LAN (lan)       -> em1        -> v4: 192.168.56.2/24
 WLAN (opt1)     -> em2        -> v4: 192.168.57.2/24

 0) Logout (SSH only)                  9) pfTop
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator password    12) PHP shell + pfSense tools
 4) Reset to factory defaults         13) Update from console
 5) Reboot system                     14) Enable Secure Shell (sshd)
 6) Halt system                       15) Restore recent configuration
 7) Ping host                         16) Restart PHP-FPM
 8) Shell

Enter an option: 
```

Figure 7: pfSense basic configuration menu

10. Take notice of the information present in the figure.

11. Register the different IPv4 addresses assigned to the WLAN, LAN and WLAN interfaces (come back to fig 1 at the beginning to better understand their meaning).

V. WLAN setup

12. Since you may not have an Ethernet interface in your personal device (laptop, smartphone, tables, etc), connect to it via WLAN to the FiberGateway:

    a) Use the SSID and credentials ('Rede/User'/Password') shown in Fiber Gateway bottom/base

    b) Open a Browser, insert URL 'http://192.168.1.254' and use 'meo'/'meo' as login credentials

13. Go to 'Wi-Fi'

    a) In the 'Rede 5GHz' tab (see figure below):

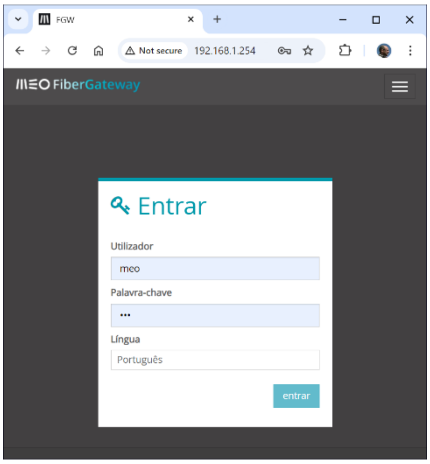
        i. Change 'Potência de transmissão' to 12.5%

    a) In the 5GHz tab (see figure below):

        ii. Change 'Largura de banda' to 20 MHz

        iii. Change WLAN 'Canal' (*Channel*) accordingly to the table below

    a) Press 'guardar'



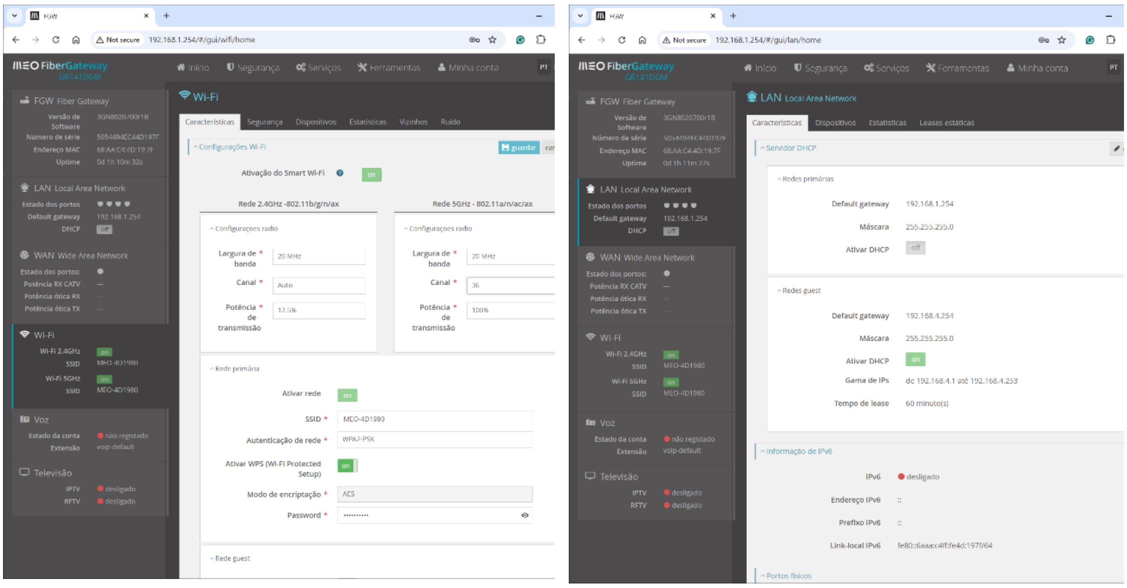
Entrar

Utilizador: meo

Palavra-chave: •••

Língua: Português

Figure 8: Fiber Gateway login screen



192.168.1.254/#/gui/wifi/home

FGW Fiber Gateway
Versão de Software 3GN8020700r1B
Número de série 5054494EC44D197F
Endereço MAC 68:AA:C4:4D:19:7F
Uptime 0d 1h 10m 32s

LAN Local Area Network
Estado dos portos ● ● ● ●
Default gateway 192.168.1.254
DHCP off

WAN Wide Area Network
Estado dos portos: ●
Potência RX CATV ---
Potência ótica RX ---
Potência ótica TX ---

Wi-Fi
Wi-Fi 2.4GHz on
SSID MEO-4D1980
Wi-Fi 5GHz on
SSID MEO-4D1980

Voz
Estado da conta ● não registado
Extensão voip-default

Televisão
IPTV ● desligado
RFTV ● desligado

Wi-Fi

Características | Segurança | Dispositivos | Estatísticas | Vizinhos | Ruido

Configurações Wi-Fi — guardar

Ativação do Smart Wi-Fi on

Rede 2.4GHz -802.11b/g/n/ax
Configurações radio
Largura de banda * 20 MHz
Canal * Auto
Potência de transmissão * 12.5%

Rede 5GHz - 802.11a/n/ac/ax
Configurações radio
Largura de banda * 20 MHz
Canal * 36
Potência de transmissão * 100%

Rede primária
Ativar rede on
SSID * MEO-4D1980
Autenticação de rede * WPA2-PSK
Ativar WPS (Wi-Fi Protected Setup) on
Modo de encriptação * AES
Password * ••••••••••

Rede guest

192.168.1.254/#/gui/lan/home

FGW Fiber Gateway
Versão de Software 3GN8020700r1B
Número de série 5054494EC44D197F
Endereço MAC 68:AA:C4:4D:19:7F
Uptime 0d 1h 11m 27s

LAN Local Area Network
Estado dos portos ● ● ● ●
Default gateway 192.168.1.254
DHCP off

WAN Wide Area Network
Estado dos portos: ●
Potência RX CATV ---
Potência ótica RX ---
Potência ótica TX ---

Wi-Fi
Wi-Fi 2.4GHz on
SSID MEO-4D1980
Wi-Fi 5GHz on
SSID MEO-4D1980

Voz
Estado da conta ● não registado
Extensão voip-default

Televisão
IPTV ● desligado
RFTV ● desligado

LAN Local Area Network

Características | Dispositivos | Estatísticas | Leases estáticas

Servidor DHCP

Redes primárias
Default gateway 192.168.1.254
Máscara 255.255.255.0
Ativar DHCP off

Redes guest
Default gateway 192.168.4.254
Máscara 255.255.255.0
Ativar DHCP on
Gama de IPs de 192.168.4.1 até 192.168.4.253
Tempo de lease 60 minuto(s)

Informação de IPv6
IPv6 ● desligado
Endereço IPv6 ::
Prefixo IPv6 ::
Link-local IPv6 fe80::6aaa:c4ff:fe4d:197f/64

Portos fisicos

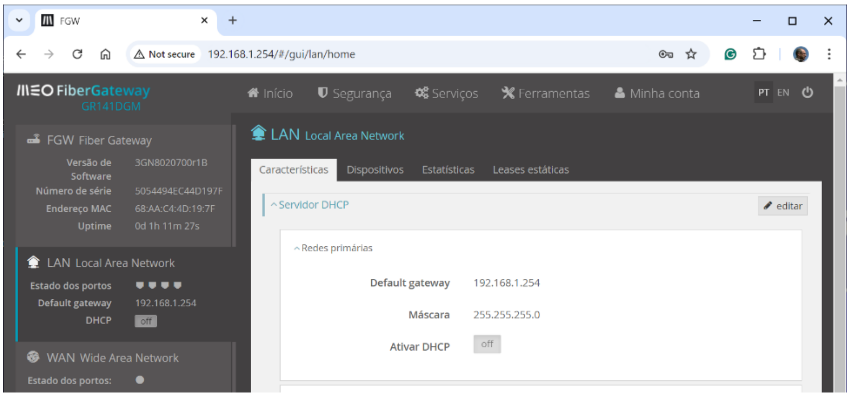
Figure 9: WLAN configurations

Group	Room/Channels	
	330	**331**
1	36	104
2	40	108
3	44	112
4	48	116
5	52	120
6	56	124
7	60	128
8	64	130
9	100	134

Table 2: WLAN channels to be configured (note: some PC's have some difficulties with higher frequencies)

14. Go to 'LAN Local Area Network', 'Características', 'Servidor DHCP', 'Redes primárias' and press 'editar'

    - Turn to 'off' in 'Activar DHCP'; press 'guardar' (*pfSenseServer is the DHCP server also for the WLAN network*)



FGW
Not secure 192.168.1.254/#/gui/lan/home
MEO FiberGateway GR141DGM
Início
Segurança
Serviços
Ferramentas
Minha conta
PT EN

FGW Fiber Gateway

Versão de Software	3GN8020700r1B
Número de série	5054494EC44D197F
Endereço MAC	68:AA:C4:4D:19:7F
Uptime	0d 1h 11m 27s

LAN Local Area Network

Estado dos portos	
Default gateway	192.168.1.254
DHCP	off

WAN Wide Area Network

Estado dos portos:

LAN Local Area Network

Características | Dispositivos | Estatísticas | Leases estáticas

Servidor DHCP — editar

Redes primárias

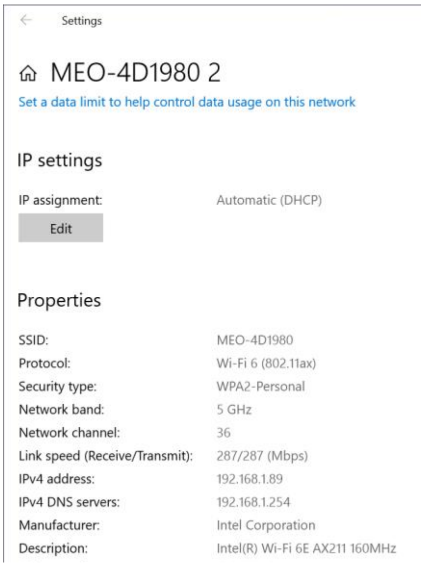
Default gateway	192.168.1.254
Máscara	255.255.255.0
Ativar DHCP	off

Figure 10: DHCP configuration

15. Connect now the ethernet cable from the USB Adapter of your PC LAB to the Fiber Gateway, using one of the yellow ethernet ports in its back; pfSense DHCP server will configure terminals connected to the AP.
16. Disconnect your terminal from the AP and reconnect it to your Fiber Gateway SSID, in the Windows/Linux WLAN interface configuration; it will get a new IP configuration.

VI. pfSense utilization

17. In your WLAN network ‘Properties’, check it is connected to the right band and channel, with correct IP addresses.



MEO-4D1980 2

Set a data limit to help control data usage on this network

IP settings

IP assignment:	Automatic (DHCP)

Properties

SSID:	MEO-4D1980
Protocol:	Wi-Fi 6 (802.11ax)
Security type:	WPA2-Personal
Network band:	5 GHz
Network channel:	36
Link speed (Receive/Transmit):	287/287 (Mbps)
IPv4 address:	192.168.1.89
IPv4 DNS servers:	192.168.1.254
Manufacturer:	Intel Corporation
Description:	Intel(R) Wi-Fi 6E AX211 160MHz

Figure 11: terminal configuration, when connected to the WLAN (example – you should get instead an IP from 192.168.57.xx)

18. Connect now one of your mobile devices and connect it via WLAN to your Fiber Gateway SSID
    - In iOS, the Captive Portal will appear immediately; if so, **do not login yet**
19. Check the assigned IP address, gateway and DNS servers of the WLAN interface (in a 'Terminal emulator', 'Command prompt' or similar console, issue command 'ip addr', 'ipconfig', or similar, depending in your OS).
20. Start a non-stopping ping to the laboratory ethernet network gateway (in Windows 'ping -t 192.168.100.1'); does it work? Leave it running even if it doesn't work (note: the -t option makes the ping work forever).
21. Open a browser and enter the URL www.ua.pt; The captive portal to authenticate and allow Internet access shall appear
    - if the Captive Portal takes some time to appear, open a second tab and enter URL http://192.168.57.2:8002/index.php?zone=wlan_portal
22. Authenticate with the first listed user ('cm'/'cm'; see Table 1)
    - You shall succeed and get the UA Portal
23. See what happens to the ping
24. Start a speed test (use the associated test URL – http://nperf.com); register the obtained speed and interpret the values
25. Logout (if the 'Disconnect' button in the pfsense page is not visible, open a new tab and enter the same URL as above)
26. See what happens to the ping
27. Disconnect and reconnect with user2 ('cm-band').
28. Go to the associated test URL, register the obtained speed and interpret the values
29. Disconnect and reconnect with user3 ('cm-time'); start a 'stopwatch'.
30. Observe the ping for more that 2 minutes, until it stops working and stop the 'stopwatch'; register the obtained time and interpret the values. Is the user still connected?
31. Reconnect with user4 (cm-traffic').
32. Go to the associated test URL and stat downloading GNS3 image. Does it conclude? Interpret the results.

VII. pfSenseConfig VM, VirtualBox installation and configuration

33. As with the pfSense VM, now, in the Desktop of the lab PC, double click the 'pfSenseConfig.ova' VM image and 'Import' it.

34. On its 'Settings' and 'Network', change 'Adapter 1' attachment to 'Host-only Adapter' and associated it to 'vboxnet0'; this will connect this VM to the 'pfSenseServer', through this internal network, with a DHCP server in pfSense (it shall be working by now and already configured for this).

35. Start the 'pfSenseConfig' VM and login to it ('labcom'/'labcom').

36. Open a 'Terminal emulator' and, with command 'ip address' check the assigned IPv4 address to the interface 'enp***xxx***'; it shall be in network 192.168.56.0/24.

37. Start a browser and enter the URL http://192.168.56.2/.

38. Since pfSense server shall now be up and running, will get the following page:

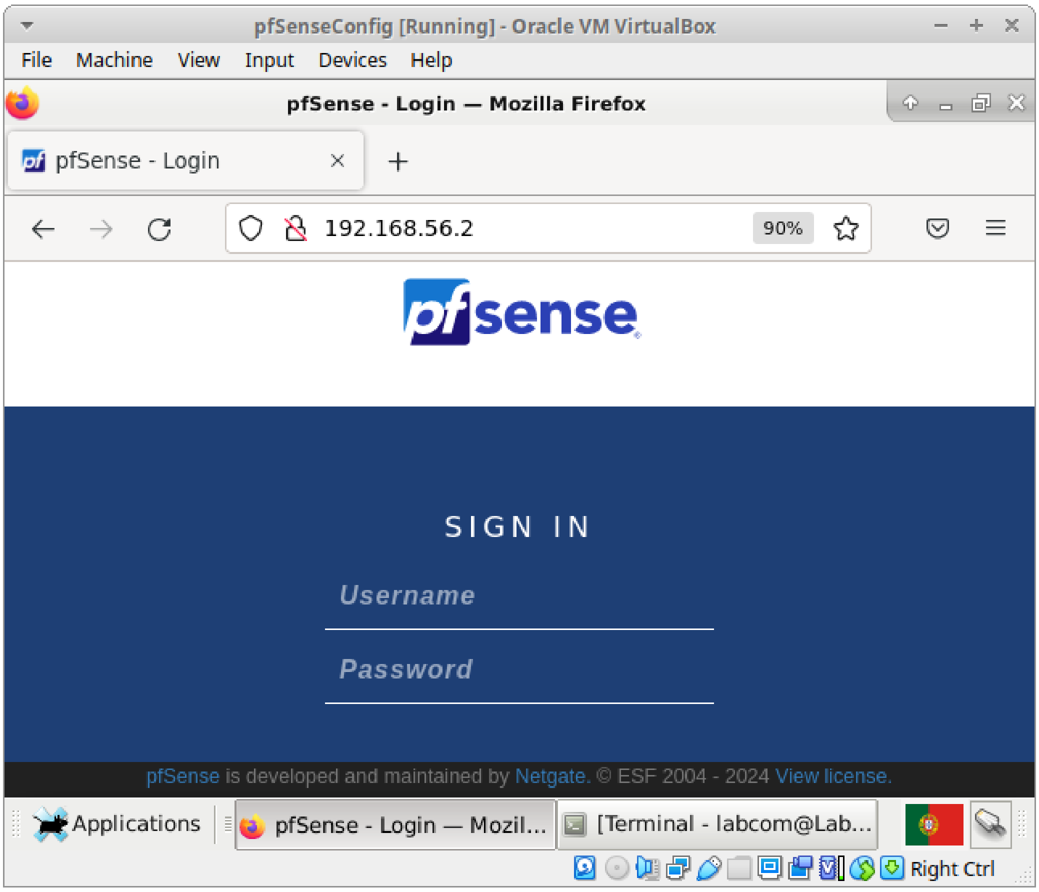

pfSenseConfig [Running] - Oracle VM VirtualBox
File
Machine
View
Input
Devices
Help
pfSense - Login — Mozilla Firefox
pfSense - Login
192.168.56.2
90%
pfsense
SIGN IN
Username
Password
pfSense is developed and maintained by Netgate. © ESF 2004 - 2024 View license.
Applications
pfSense - Login — Mozil...
[Terminal - labcom@Lab...
Right Ctrl

Figure 12: pfSense configuration portal

39. Login with credentials 'admin'/'pfSense'.

    - **DO NOT CHANGE ANYTHING UNLESS IT IS REQUESTED IN THIS GUIDE**

40. Go to 'System' → 'General Setup' and observe the configured parameters.

41. Go to 'System' → 'Package Manager' and observe the existence of 'freeradius3'.

42. Go to 'System' → 'Routing' → 'Gateways' and observe the obtained (DHCP) configuration.

43. Go to 'Interfaces' → 'Assignments' and interpret the existing three correspondences.

- Click in each of them and check their configuration.

44. Go to 'Firewall' → 'Aliases' → 'All' and interpret the list of shown IP addresses.
45. Go to 'Firewall' → 'Rules' → 'WLAN' and interpret the shown rule.
46. Go to 'Services' → 'DHCP Server' and interpret the LAN and WLAN configurations.
47. Go to 'Services' → 'DNS Forwarder' and interpret the configuration.
48. Go to 'Services' → 'Captive Portal' and edit the 'Zone' 'WLAN_Portal'; interpret the configuration; pay attention to the defined 'Default download/upload' values.
49. Go to 'Services' → 'FreeRADIUS' and check the existence of the user 'labcom'; edit it and interpret the configured parameters; try to figure out what will happen to the sessions of this user.
50. Go into the editing mode of that user (the occulted password is 'labcom').
51. Go to the pfsenseServer VM and *halt the system* (option 6, **'Halt system'**).
    - **DO NOT SHUTDOWN THE VM OR PC WITHOUT DOING THIS**

VIII. References

https://www.youtube.com/watch?v=hqjE4KySvWU

https://docs.netgate.com/pfsense/en/latest/

https://www.pfsense.org/

IX. Utilizadores

- **Sem limitações**

Login: cm

Pass: cm

Usar ping e web para verificar estabelecimento do acesso

Logout efetuado pelo utilizador

- Com limitação temporal de 2 minutos

Login: cm-time

Pass: cm

Usar ping e web para verificar que o acesso será cortada ao fim do tempo disponibilizado.

Logout efetuado automaticamente

- Com limitação de 1024Kbs download e 128Kbs upload

Login: cm-band

Pass: cm

Usar www.nperf.com para verificar a largura de banda disponibilizada.

Logout efetuado pelo utilizador

- Com limitação de 64Mb para download e upload

Login: cm-traffic

Pass: cm

Fazer download de uma das VMs no site www.gns3.com/software/download-vm para verificar que o acesso será cortada ao fim do dados disponibilizado.

Logout efetuado automaticamente