

Laboratorio 2 de Redes 1

2. Objetivo

En esta práctica se plantean los siguientes objetivos:

- Configurar un entorno de red de transporte para dos DCs, mediante VXLAN.
- Emplear GNS3-VM Alpha, así como Cumulus Linux para implementar la prueba de concepto de VXLAN
- Comprender mediante la práctica el concepto de Open Networking, VXLAN, Cumulus Linux y todos los elementos y protocolos que componen este entorno de redes moderno.

3. Materiales

La presente práctica requiere al menos los siguientes materiales:

- Una PC de 64-Bits, con 8GB de RAM
- Software GNS3-VM con imágenes de Cumulus Linux
- Acceso a Internet
- Acceso a manuales de GNS3-VM y Cumulus Linux

4. Procedimiento

No olvide incluir captura de pantallas (las que considere pertinentes) de todas las actividades realizadas durante la práctica.

Paso 1

- Inicialice GNS3-VM con Cumulus Linux
- Ubique la topología a emular según el Anexo A.

Paso 2

- Realice todos los pasos necesarios para lograr conectividad de extremo a extremo (Anexo B).

Paso 3

- Capture todas las pantallas que considere necesarias como evidencia de su trabajo.

5. Cuestionario

Responda a las siguientes preguntas:

- Defina Qué es e indique la importancia de Cumulus Linux para Open Networking.
- ¿Qué es VXLAN y Cuál es su proceso de encapsulación – INNER y OUTER?
- ¿En qué se relaciona VXLAN con EVPN?
- ¿En qué se relaciona VXLAN con SDN?
- Realice un breve resumen sobre las Eras del Networking

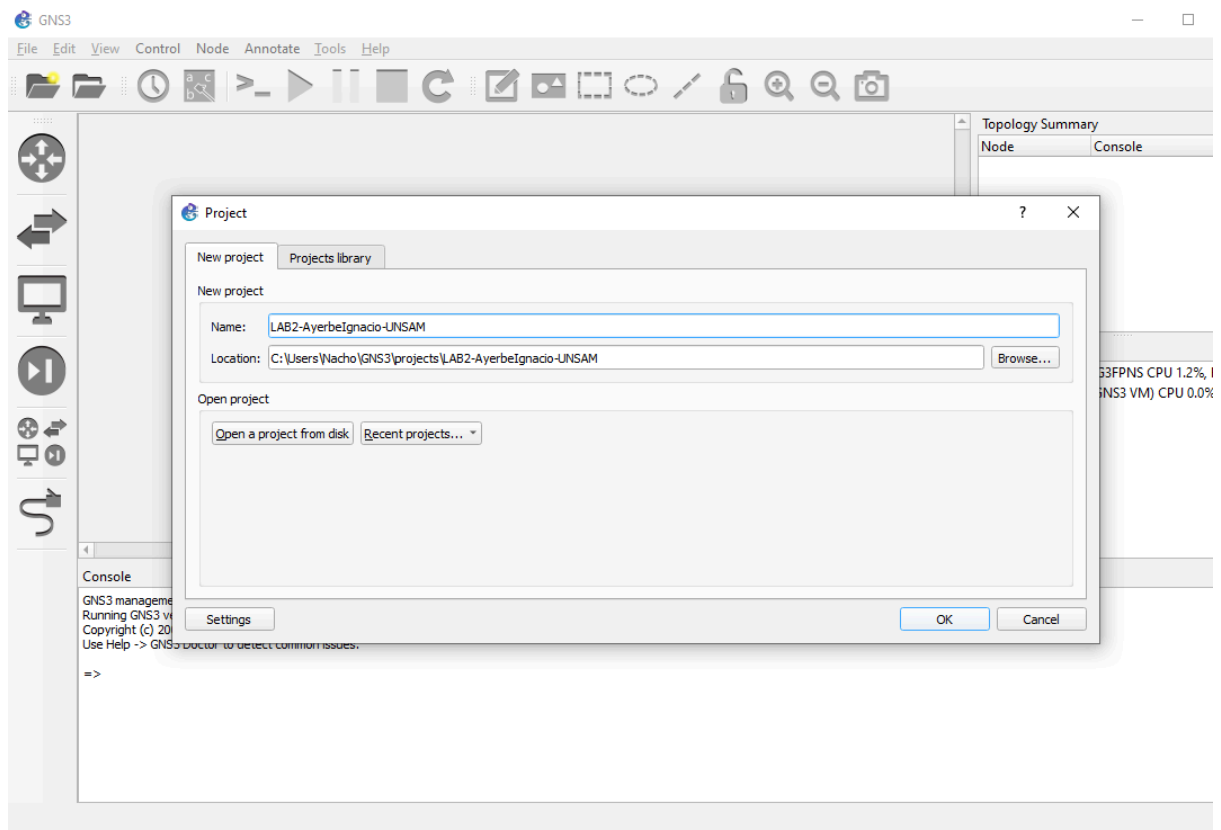
6. Conclusiones y Recomendaciones

Exponer al menos tres conclusiones y tres recomendaciones

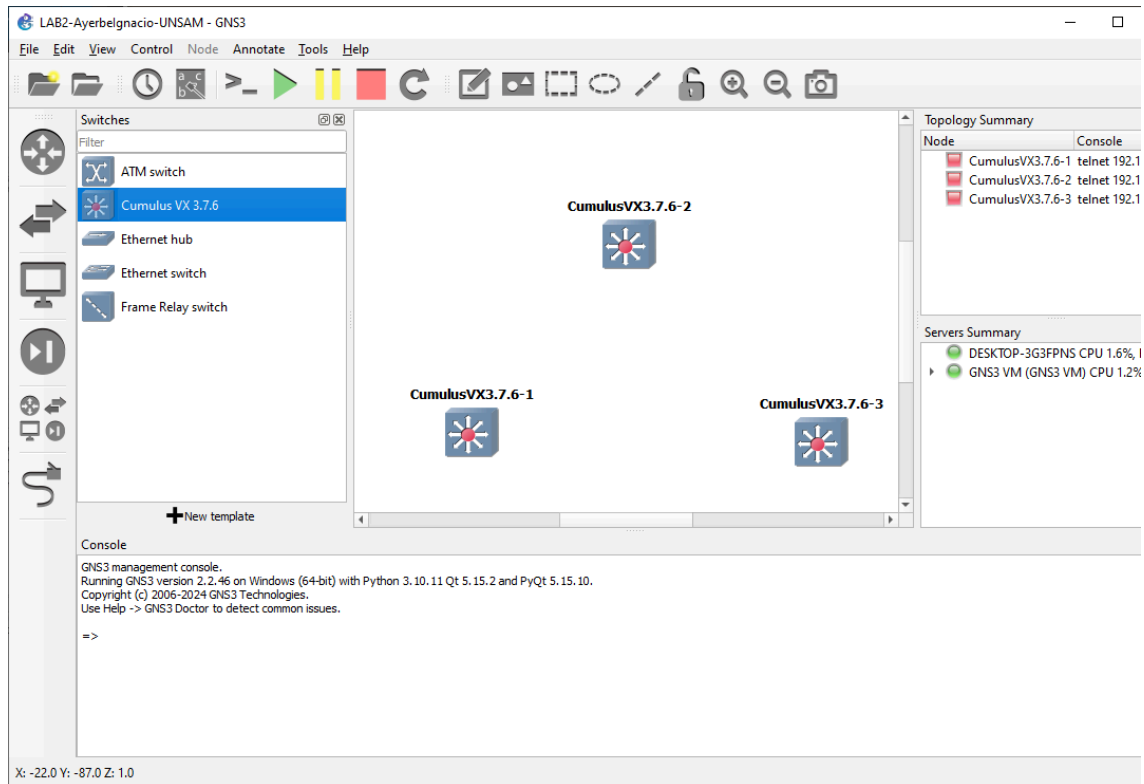
7. Bibliografía

Indicar la Bibliografía utilizada en formato APA

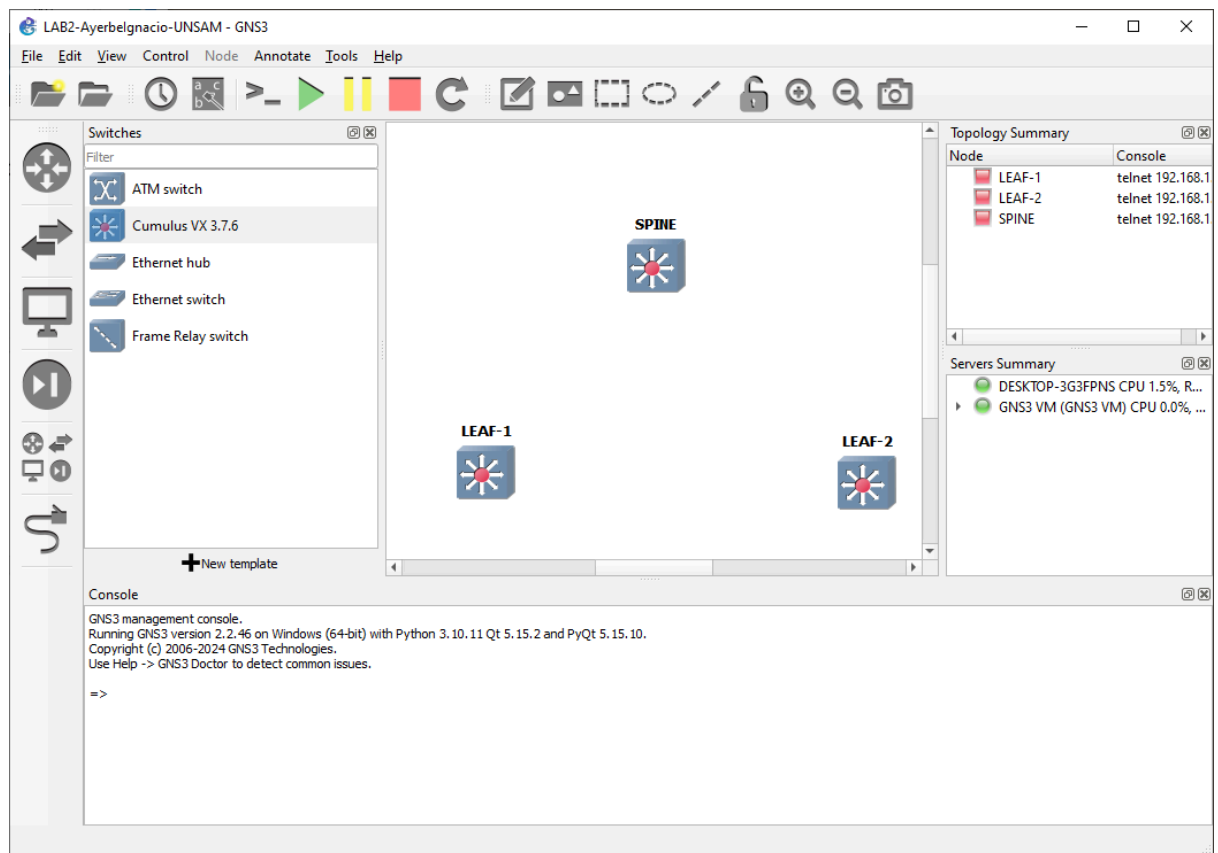
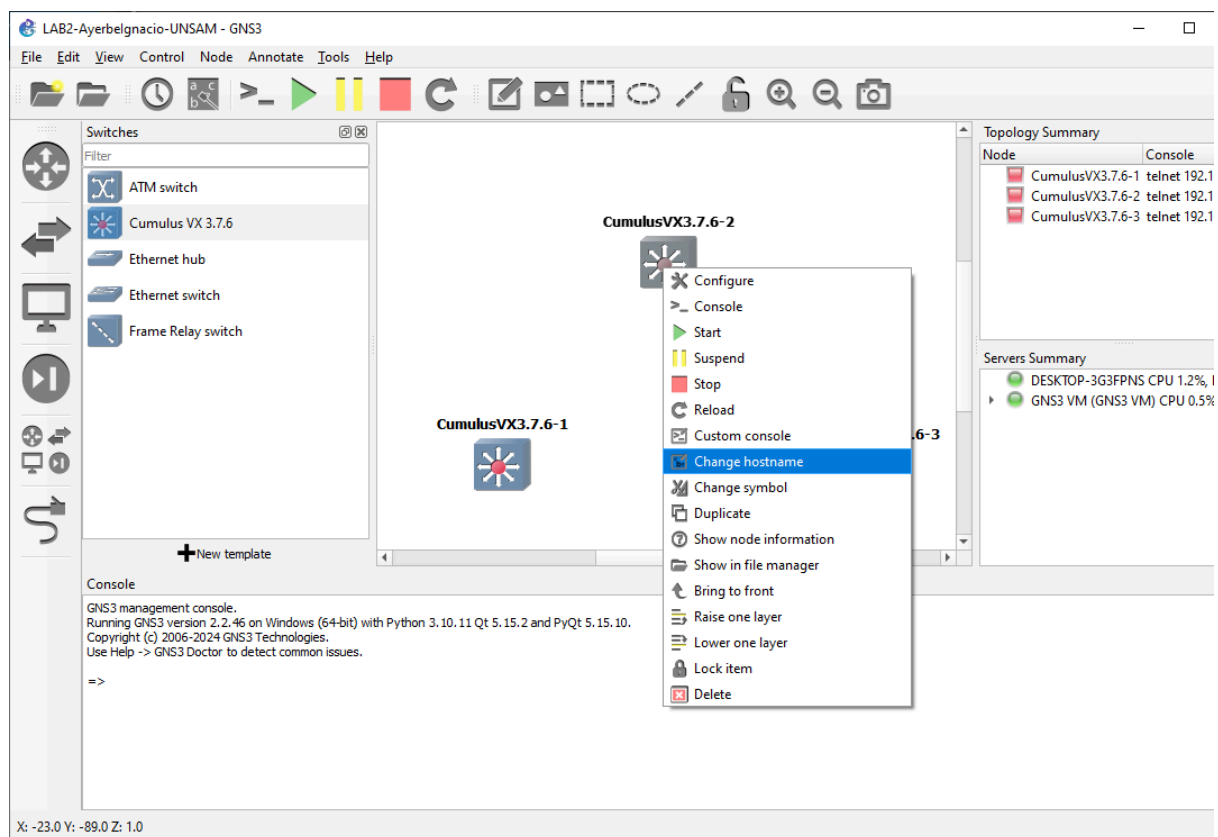
Iniciamos el programa GNS-3 y creamos un nuevo proyecto llamado "LAB2-Ayerbelgnacio-UNSAM"



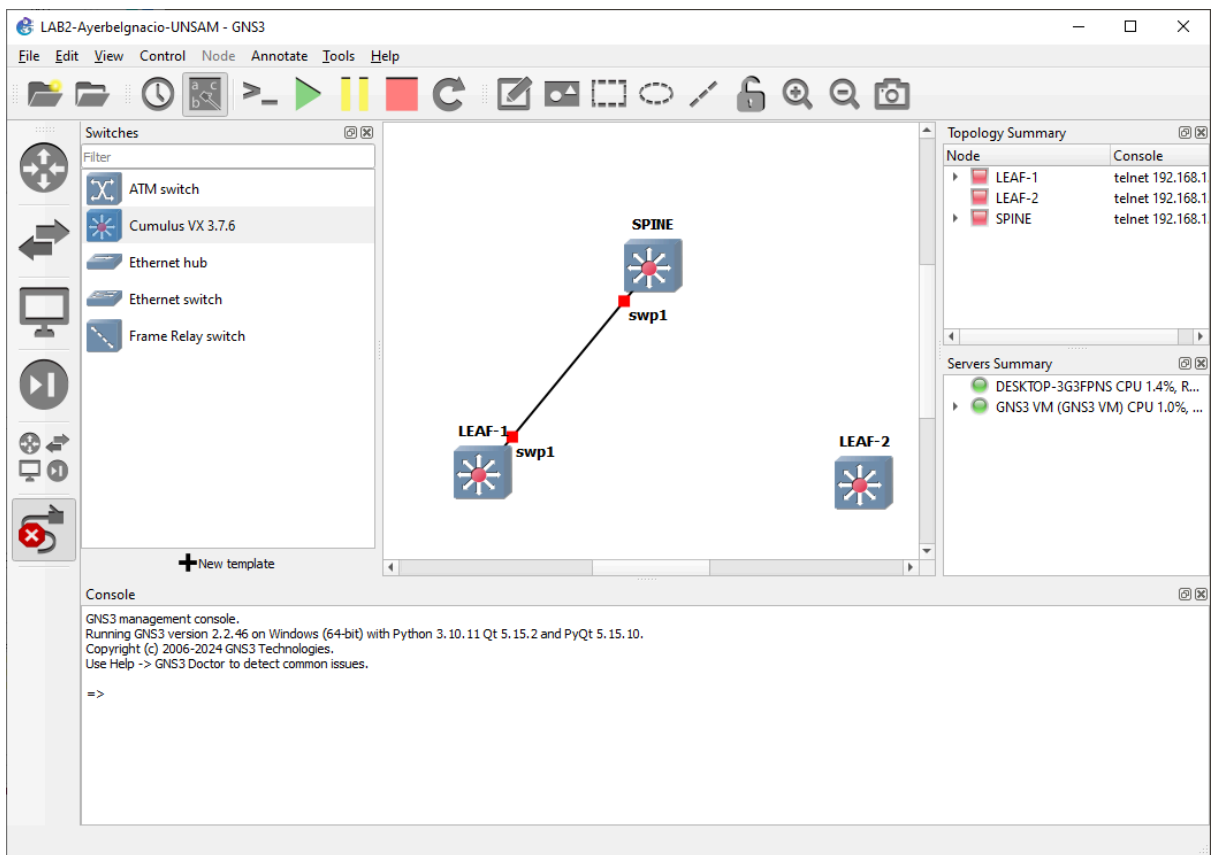
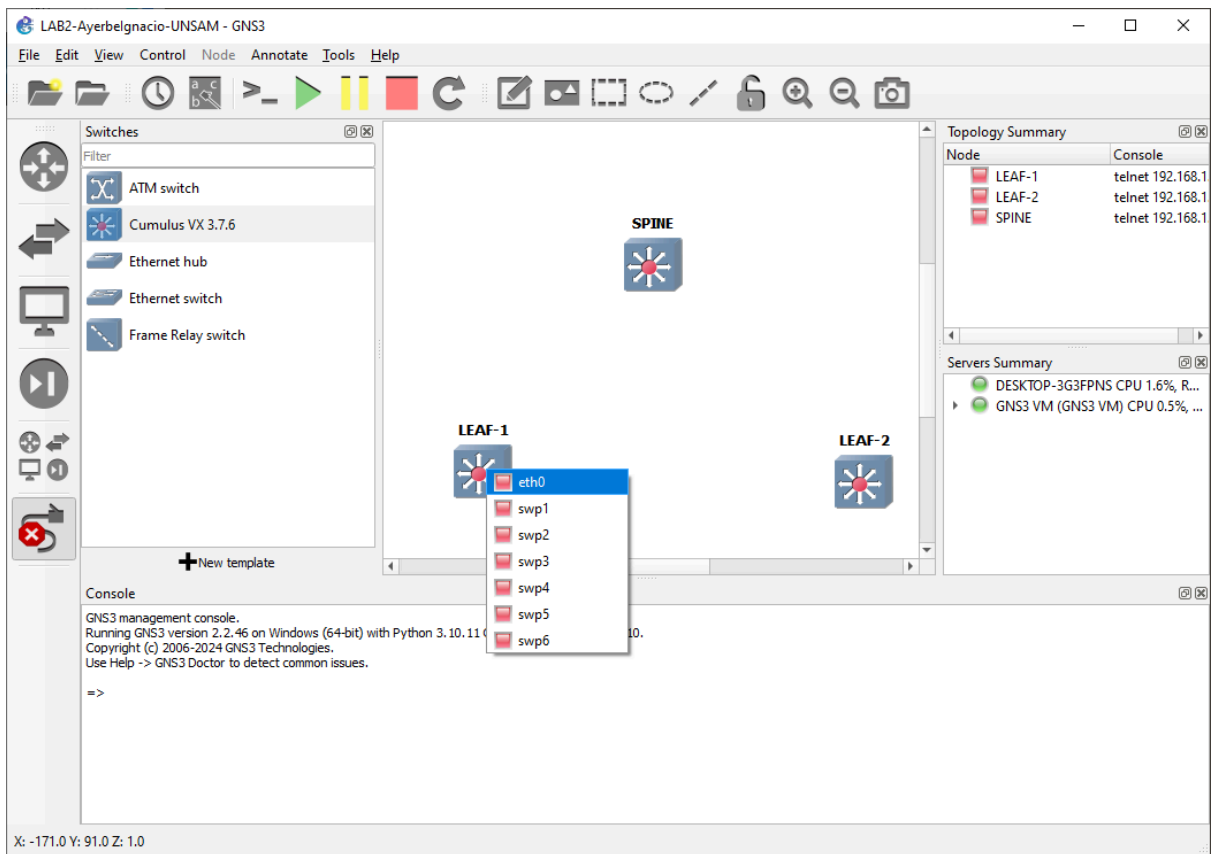
Colocamos 3 switches en el área de trabajo que representan la topología “SPINE-LEAF” de VXLAN

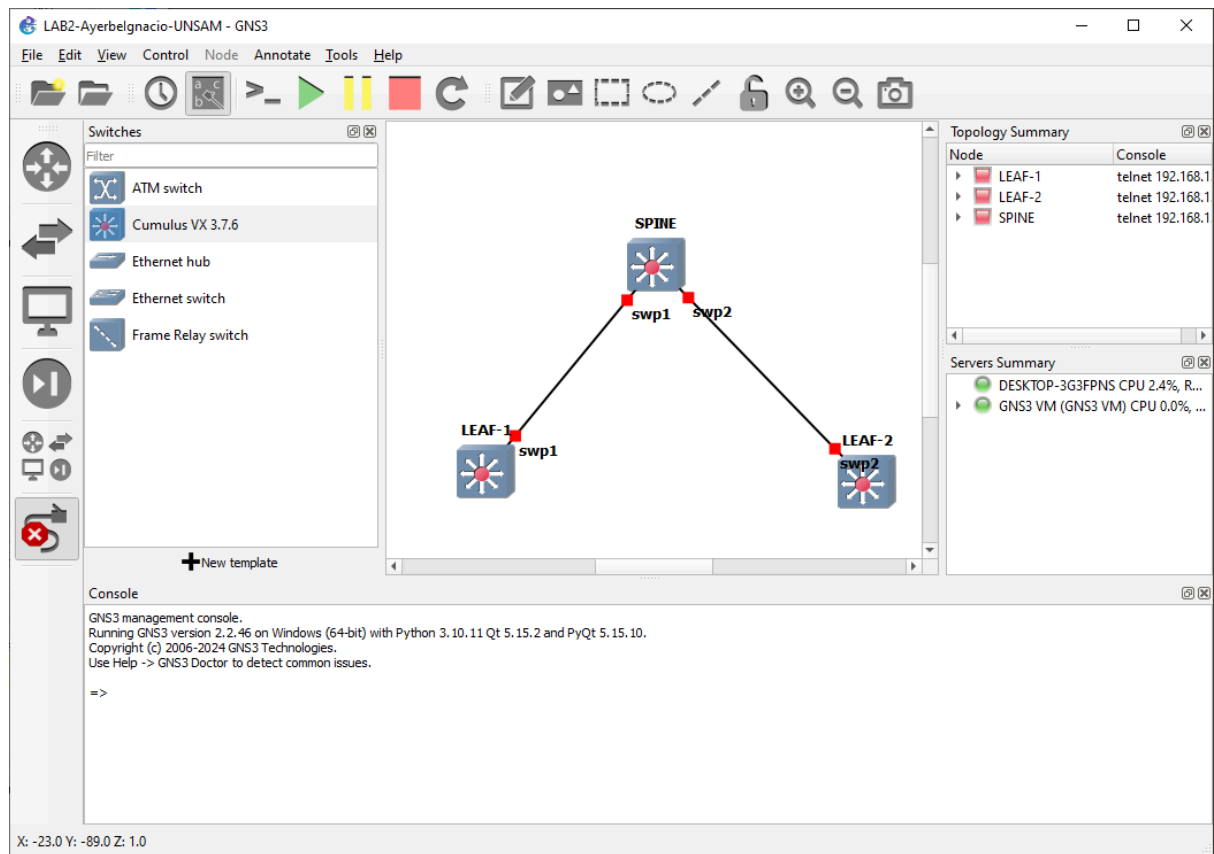


El equipo del medio será el SPINE y los dos siguientes serán los LEAVES, para ello cambiamos el nombre de los dispositivos

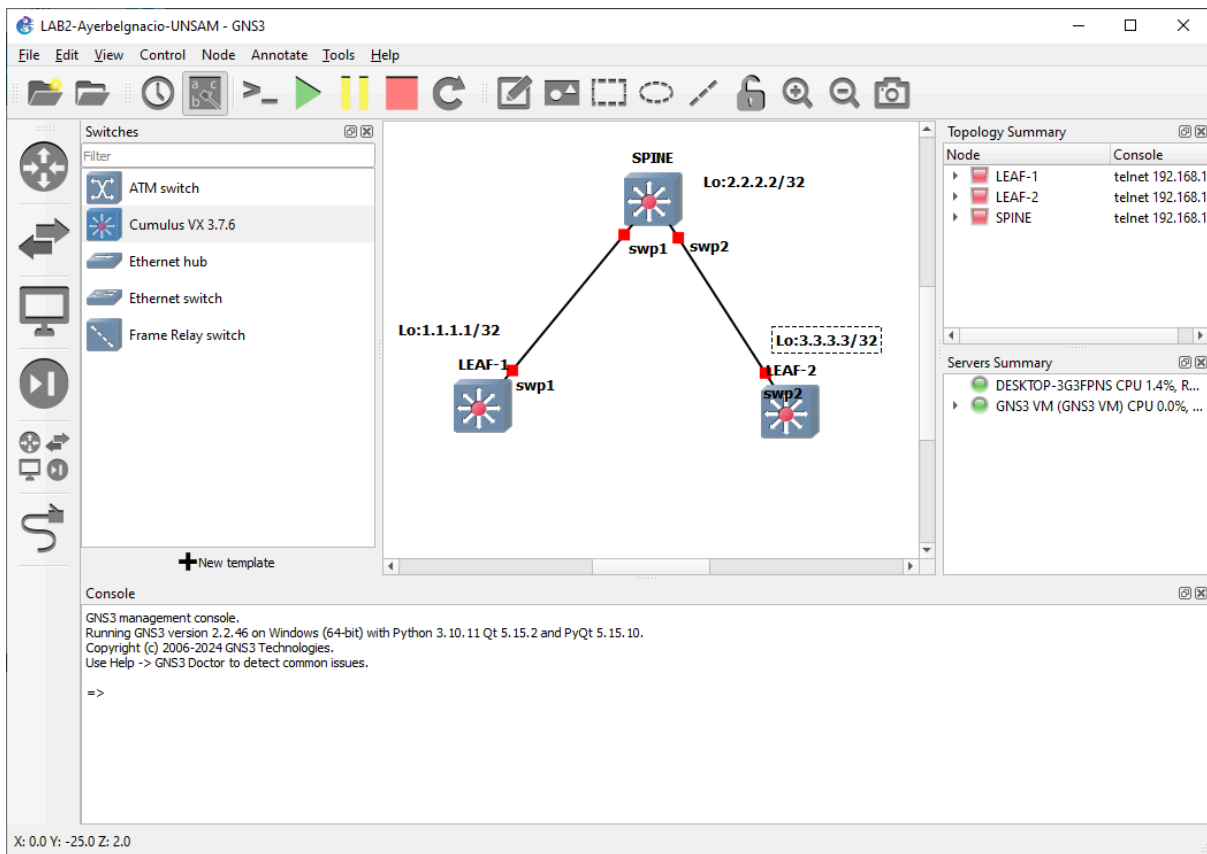


Luego conectamos los dispositivos de los extremos hacia el SPINE. En este caso conectamos el LEAF-1 con el SPINE en swp1 y el LEAF-2 en swp2.

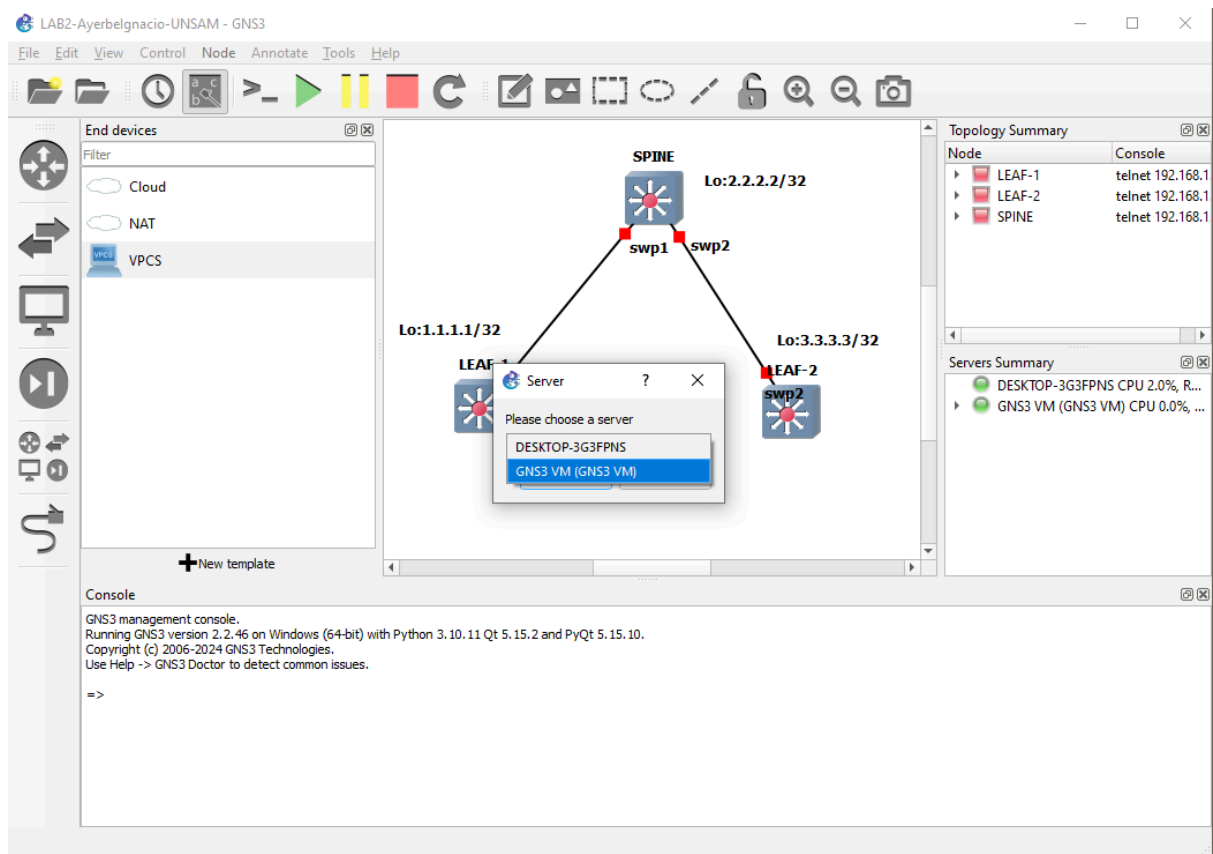
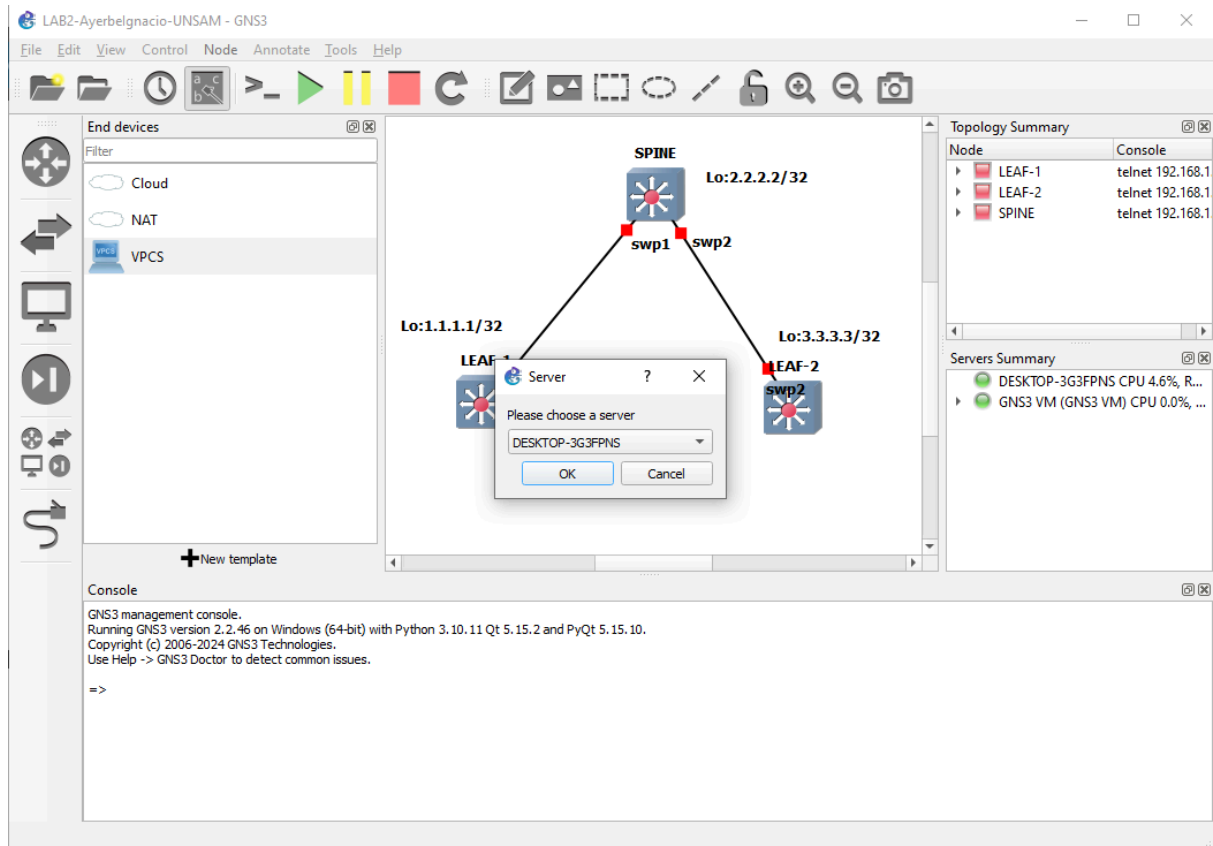




Agregamos los datos de la infraestructura (IP, interfaces de loopback)



Ahora agregamos una PC (host) para cada LEAF, escogiendo el server VM.



LAB2-Ayerbelgnacio-UNSAM - GNS3

File Edit View Control Node Annotate Tools Help

End devices

Filter

Cloud

NAT

VPCS

+

New template

Lo:1.1.1.1/32

LEAF-1

swp1

swp6

PC1

e0

VPCS

Lo:2.2.2.2/32

SPINE

swp1

swp2

Lo:3.3.3.3/32

LEAF-2

swp2

swp6

PC2

e0

VPCS

Topology Summary

Node	Console
LEAF-1	telnet 192.168.171.131:50...
LEAF-2	telnet 192.168.171.131:50...
PC1	telnet 192.168.171.131:50...
PC2	telnet 192.168.171.131:50...
SPINE	telnet 192.168.171.131:50...

Servers Summary

DESKTOP-3G3FPNS CPU 2.4% R...

GNS3 VM (GNS3 VM) CPU 0.5% ...

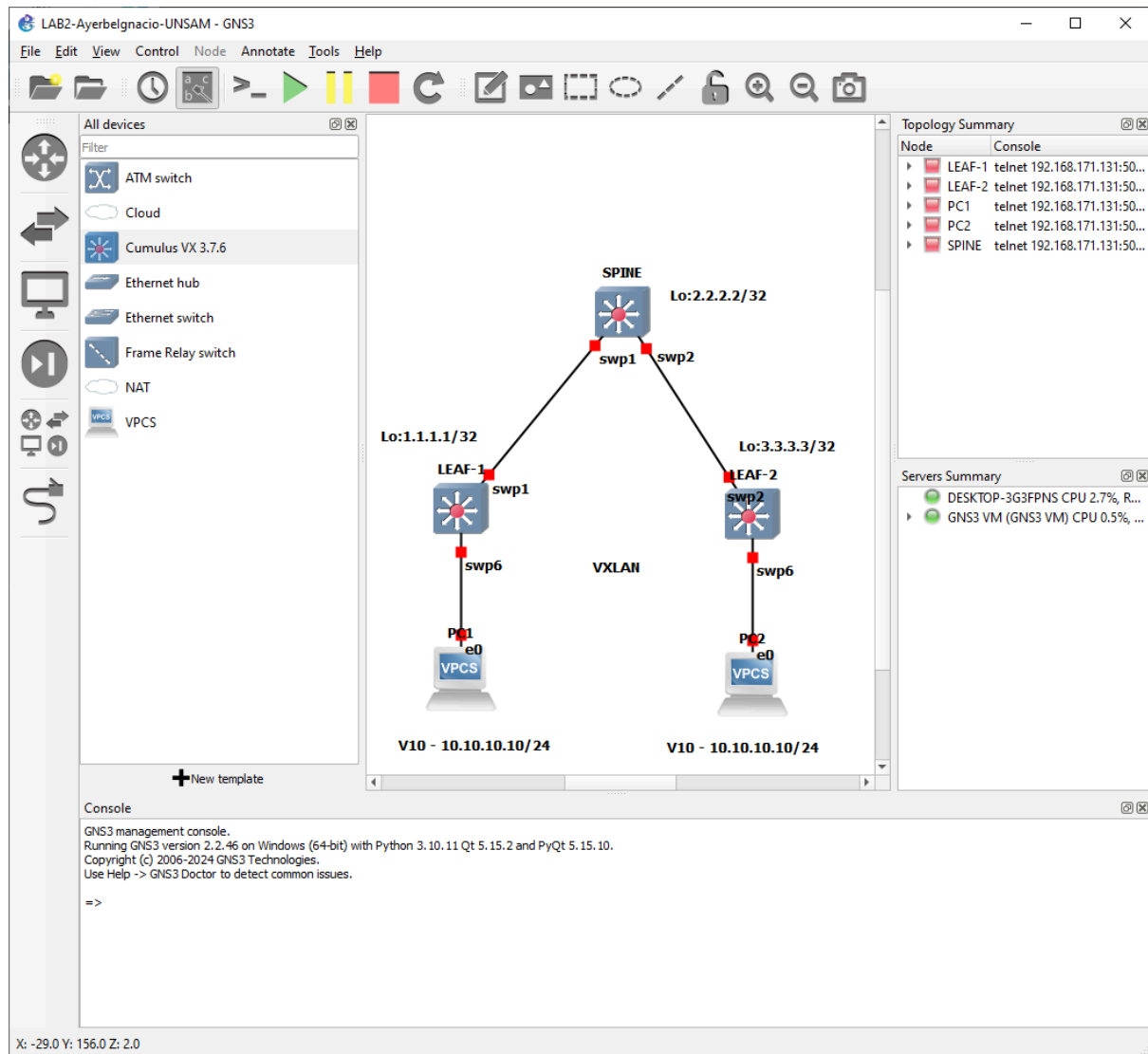
Console

GNS3 management console.
Running GNS3 version 2.2.46 on Windows (64-bit) with Python 3.10.11 Qt 5.15.2 and PyQt 5.15.10.
Copyright (c) 2006-2024 GNS3 Technologies.
Use Help -> GNS3 Doctor to detect common issues.

=>

X: 89.0 Y: 246.0 Z: 1.0

Agregamos la información de la VLAN que pertenece y la dirección IP.



Hasta ahora tenemos 3 Switches, que 2 se conectan al SPINE y a su vez esos 2 switches tiene un host cada uno conectado. Tenemos todo el diagrama hecho pero nos falta conectar los elementos entre sí, con sus direcciones IP y VLANs.

ANEXO B

Ahora encendemos los equipos con el botón Play

LAB2-Ayerbelgnacio-UNSAM - GNS3

File Edit View Control Node Annotate Tools Help

All devices

Filter

- ATM switch
- Cloud
- Cumulus VX 3.7.6
- Ethernet hub
- Ethernet switch
- Frame Relay switch
- NAT
- VPCS

Topology Summary

Node	Console
LEAF-1	telnet 192.168.171.131:50...
LEAF-2	telnet 192.168.171.131:50...
PC1	telnet 192.168.171.131:50...
PC2	telnet 192.168.171.131:50...
SPINE	telnet 192.168.171.131:50...

Servers Summary

- DESKTOP-3G3FPNS CPU 3.7%, R...
- GNS3 VM (GNS3 VM) CPU 0.0%, ...

Confirm Start All

Are you sure you want to start all devices?

Yes No

Lo:1.1.1.1/32

Lo:2.2.2.2/32

Lo:3.3.3.3/32

swp1 swp2

swp6

P01 e0

P02 e0

V10 - 10.10.10.10/24

V10 - 10.10.10.10/24

Console

GNS3 management console.
Running GNS3 version 2.2.46 on Windows (64-bit) with Python 3.10.11 Qt 5.15.2 and PyQt 5.15.10.
Copyright (c) 2006-2024 GNS3 Technologies.
Use Help -> GNS3 Doctor to detect common issues.

=>

LAB2-Ayerbelgnacio-UNSAM - GNS3

File Edit View Control Node Annotate Tools Help

All devices

Filter

- ATM switch
- Cloud
- Cumulus VX 3.7.6
- Ethernet hub
- Ethernet switch
- Frame Relay switch
- NAT
- VPCS

Topology Summary

Node	Console
LEAF-1	telnet 192.168.171.131:5000
LEAF-2	telnet 192.168.171.131:5004
PC1	telnet 192.168.171.131:5006
PC2	telnet 192.168.171.131:5008
SPINE	telnet 192.168.171.131:5002

Servers Summary

- DESKTOP-3G3FPNS CPU 10.9%, RA...
- GNS3 VM (GNS3 VM) CPU 100.0%, ...

Console

GNS3 management console.
Running GNS3 version 2.2.46 on Windows (64-bit) with Python 3.10.11 Qt 5.15.2 and PyQt 5.15.10.
Copyright (c) 2006-2024 GNS3 Technologies.
Use Help -> GNS3 Doctor to detect common issues.

=>

X: 0.0 Y: 54.0 Z: 2.0

The diagram shows a network topology with three switches: SPINE, LEAF-1, and LEAF-2. SPINE is at the top, connected to LEAF-1 on the left and LEAF-2 on the right. LEAF-1 is connected to PC1, and LEAF-2 is connected to PC2. The switches are labeled with their IP addresses: SPINE (Lo:2.2.2.2/32), LEAF-1 (Lo:1.1.1.1/32), and LEAF-2 (Lo:3.3.3.3/32). The PCs are labeled with their IP addresses: PC1 (V10 - 10.10.10.10/24) and PC2 (V10 - 10.10.10.10/24). The connections are labeled with interface names: swp1, swp2, swp6, and e0. The topology is labeled VXLAN.

Ahora procedemos a configurar las interfaces físicas y Loopbacks de cada equipo: Empezamos por LEAF-1, doy click derecho y selecciono la consola.

The screenshot shows the GNS3 network simulator interface. The main workspace displays a network topology with three switches: SPINE, LEAF-1, and LEAF-2. SPINE is connected to LEAF-1 and LEAF-2. LEAF-1 is connected to a PC (PC1) and a VPCS (VPCS1). LEAF-2 is connected to a PC (PC2) and a VPCS (VPCS2). The topology is labeled with IP addresses and interface names: SPINE (Lo:2.2.2.2/32), LEAF-1 (Lo:1.1.1.1/32), LEAF-2 (Lo:3.3.3.3/32), PC1 (10.10.10.10/24), PC2 (10.10.10.10/24), VPCS1 (10.10.10.10/24), and VPCS2 (10.10.10.10/24).

A right-click context menu is open over LEAF-1, showing options: Configure, Console, Start, Suspend, Stop, Reload, Custom console, Change hostname, Change symbol, Duplicate, Show node information, Show in file manager, Bring to front, Raise one layer, Lower one layer, Lock item, and Delete. The 'Console' option is highlighted.

The 'All devices' panel on the left shows a list of devices: ATM switch, Cloud, Cumulus VX 3.7.6, Ethernet hub, Ethernet switch, Frame Relay switch, NAT, and VPCS. The 'Topology Summary' panel on the right shows a table of nodes and their console addresses:

Node	Console
LEAF-1	telnet 192.168.171.131:5000
LEAF-2	telnet 192.168.171.131:5004
PC1	telnet 192.168.171.131:5006
PC2	telnet 192.168.171.131:5008
SPINE	telnet 192.168.171.131:5002

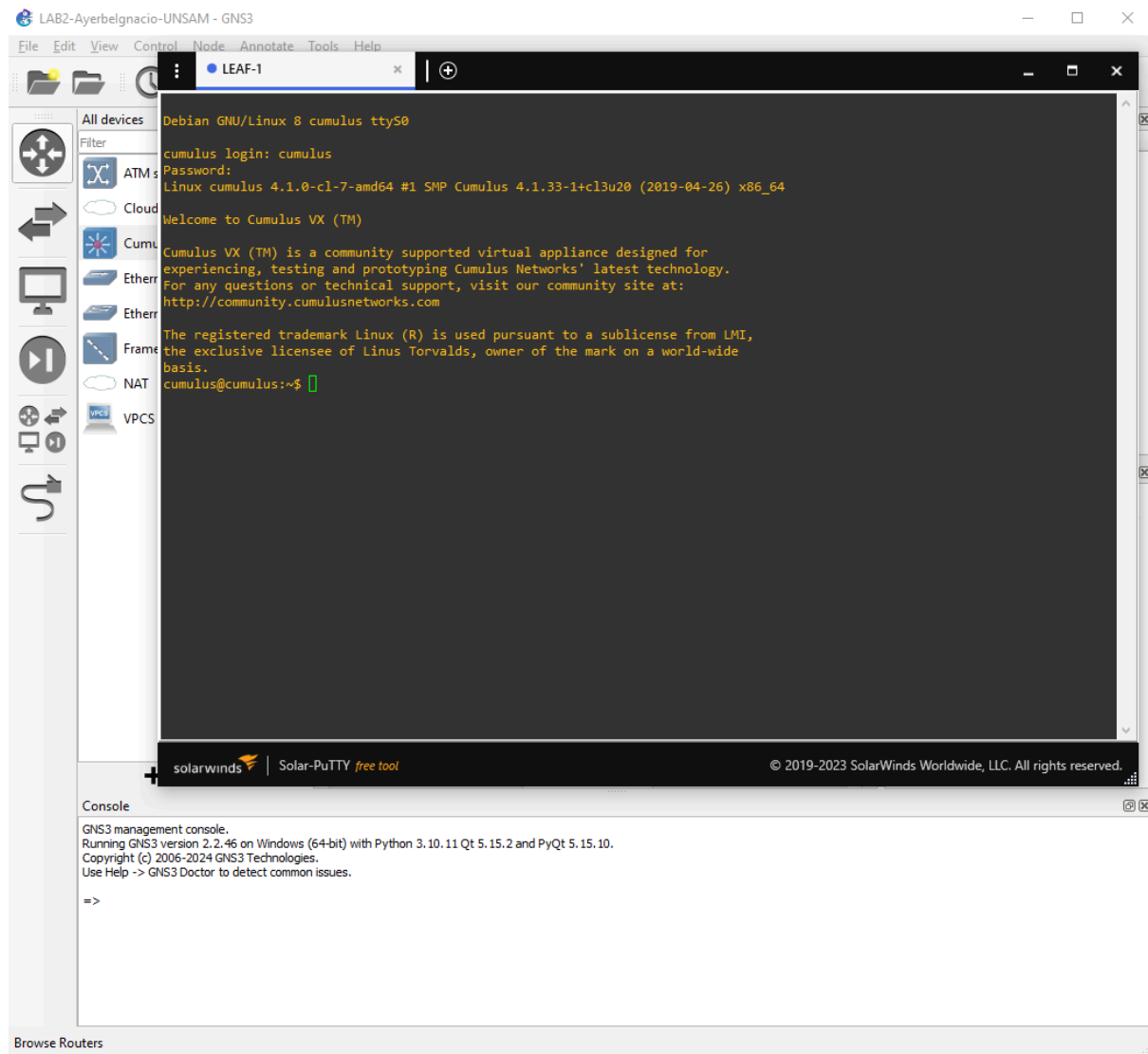
The 'Servers Summary' panel on the right shows a table of servers and their CPU usage:

Servers Summary
DESKTOP-3G3FPNS CPU 2.1%, RA...
GNS3 VM (GNS3 VM) CPU 0.0%, R...

The console window at the bottom shows the GNS3 management console output:

```
GNS3 management console.  
Running GNS3 version 2.2.46 on Windows (64-bit) with Python 3.  
Copyright (c) 2006-2024 GNS3 Technologies.  
Use Help -> GNS3 Doctor to detect common issues.  
=>
```

Ingresamos Usuario (cumulus) y contraseña (CumulusLinux!)



Configuramos las interfaces físicas:

- swp1: 5.5.5.1/30
- Loopback: 1.1.1.1/32

```
LEAF-1
Debian GNU/Linux 8 cumulus ttyS0

cumulus login: cumulus
Password:
Linux cumulus 4.1.0-cl-7-amd64 #1 SMP Cumulus 4.1.33-1-cl3u20 (2019-04-26) x86_64

Welcome to Cumulus VX (TM)

Cumulus VX (TM) is a community supported virtual appliance designed for
experiencing, testing and prototyping Cumulus Networks' latest technology.
For any questions or technical support, visit our community site at:
http://community.cumulusnetworks.com

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the exclusive licensee of Linus Torvalds, owner of the mark on a world-wide
basis.
cumulus@cumulus:~$ net add swp1 ip address 5.5.5.1/30
ERROR: Command not found.

net add swp1 ip address 5.5.5.1/30
^ Invalid value here.

Use "net help KEYWORD(s)" to list all options that use KEYWORD(s).
cumulus@cumulus:~$ net add interface swp1 ip address 5.5.5.1/30
cumulus@cumulus:~$ net add loopback li ip address 1.1.1.1/32
ERROR: Command not found.

net add loopback li ip address 1.1.1.1/32
^ Invalid value here.

Use "net help KEYWORD(s)" to list all options that use KEYWORD(s).
cumulus@cumulus:~$ net add loopback lo ip address 1.1.1.1/32
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2019-05-03 05:39:38.000000000 +0000
+++ /run/nclu/ifupdown2/interfaces.tmp 2024-03-26 19:33:19.250000000 +0000
@@ -1,12 +1,19 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).
```

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A lo ultimo de cada configuración de cada dispositivo hacemos un net commit, para poder guardar los cambios hechos.

```
net add loopback lo ip address 1.1.1.1/32
^ Invalid value here.

Use "net help KEYWORD(s)" to list all options that use KEYWORD(s).
cumulus@cumulus:~$ net add loopback lo ip address 1.1.1.1/32
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2019-05-03 05:39:38.000000000 +0000
+++ /run/nclu/ifupdown2/interfaces.tmp 2024-03-26 19:33:19.250000000 +0000
@@ -1,12 +1,19 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*.intf

# The loopback network interface
auto lo
iface lo inet loopback
+ # The primary network interface
+ address 1.1.1.1/32

# The primary network interface
auto eth0
iface eth0 inet dhcp
+
+auto swp1
+iface swp1
+ address 5.5.5.1/30
+

net add/del commands since the last "net commit"
=====

User      Timestamp                Command
-----
cumulus   2024-03-26 19:32:39.900168 net add interface swp1 ip address 5.5.5.1/30
cumulus   2024-03-26 19:33:06.757664 net add loopback lo ip address 1.1.1.1/32
cumulus@cumulus:~$
```

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En LEAF-2 configuramos:

- swp2: 7.7.7.1/30
- Loopback 3.3.3.3/32

```
LEAF-1 | LEAF-2 x | +
The registered trademark Linux (R) is used pursuant to a sublicense from LMI,
the exclusive licensee of Linus Torvalds, owner of the mark on a world-wide
basis.
cumulus@cumulus:~$ net add interface swp2 ip address 7.7.7.1/30
cumulus@cumulus:~$ net add loopback lo ip address 3.3.3.3/32
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2019-05-03 05:39:38.000000000 +0000
+++ /run/ncclu/ifupdown2/interfaces.tmp  2024-03-26 19:35:29.378000000 +0000
@@ -1,12 +1,19 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*.intf

# The loopback network interface
auto lo
iface lo inet loopback
+ # The primary network interface
+ address 3.3.3.3/32

# The primary network interface
auto eth0
iface eth0 inet dhcp
+
+auto swp2
+iface swp2
+ address 7.7.7.1/30
+

net add/del commands since the last "net commit"
=====

User      Timestamp                Command
-----
cumulus   2024-03-26 19:35:03.541039 net add interface swp2 ip address 7.7.7.1/30
cumulus   2024-03-26 19:35:25.799700 net add loopback lo ip address 3.3.3.3/32
cumulus@cumulus:~$
```

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LEAF-1LEAF-2SPINE

```
cumulus@cumulus:~$ net add interface swp2 ip address 7.7.7.2/30
cumulus@cumulus:~$ net add loopback lo ip address 2.2.2.2/32
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2019-05-03 05:39:38.000000000 +0000
+++ /run/nclu/ifupdown2/interfaces.tmp 2024-03-26 19:37:00.832000000 +0000
@@ -1,12 +1,23 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*.intf

# The loopback network interface
auto lo
iface lo inet loopback
+ # The primary network interface
+ address 2.2.2.2/32

# The primary network interface
auto eth0
iface eth0 inet dhcp
+
+auto swp1
+iface swp1
+ address 5.5.5.2/30
+
+auto swp2
+iface swp2
+ address 7.7.7.2/30
+

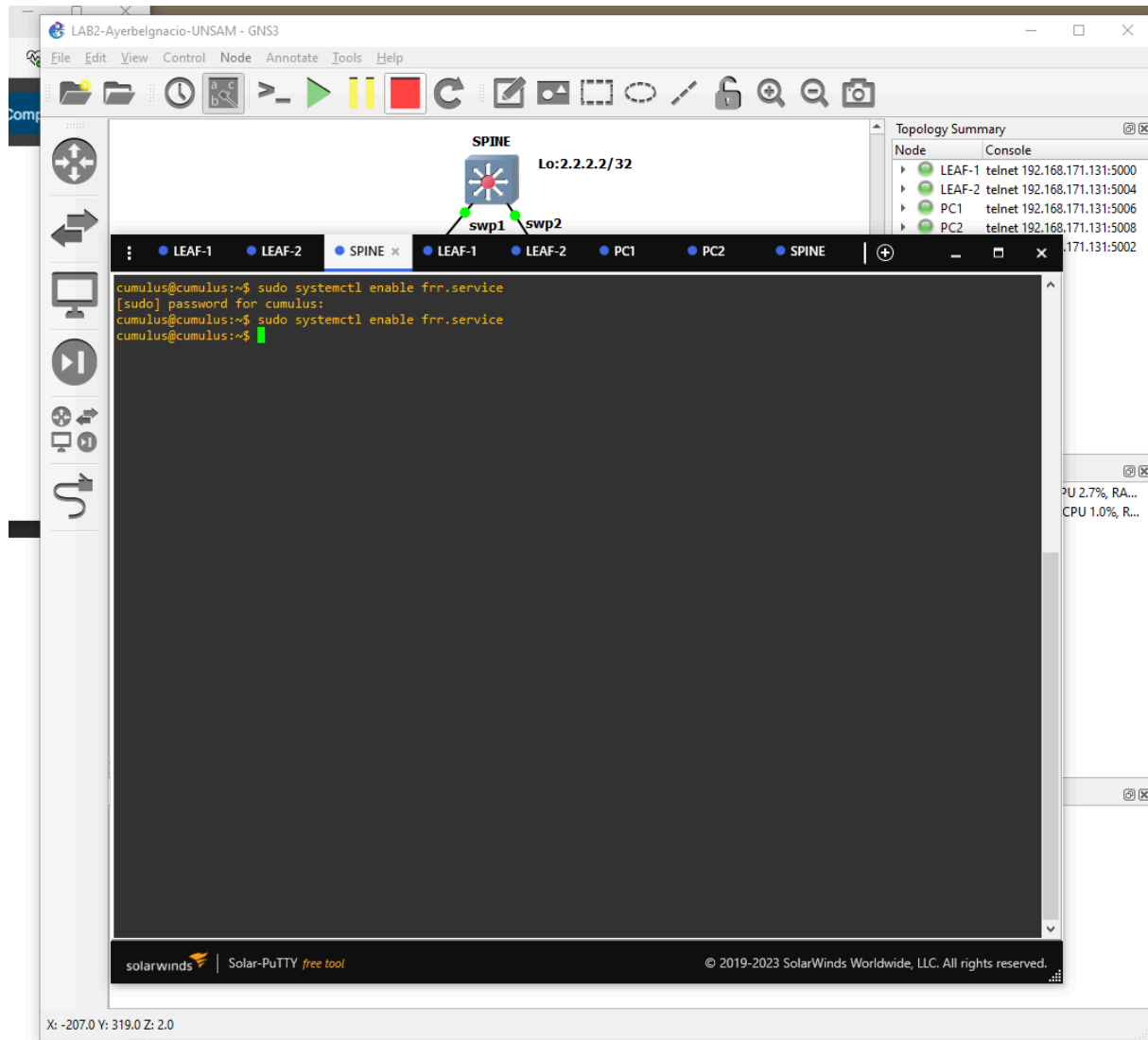
net add/del commands since the last "net commit"
=====

User      Timestamp                Command
-----
cumulus   2024-03-26 19:36:40.524403 net add interface swp1 ip address 5.5.5.2/30
cumulus   2024-03-26 19:36:48.542464 net add interface swp2 ip address 7.7.7.2/30
```

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Y por último en SPINE, configuramos:

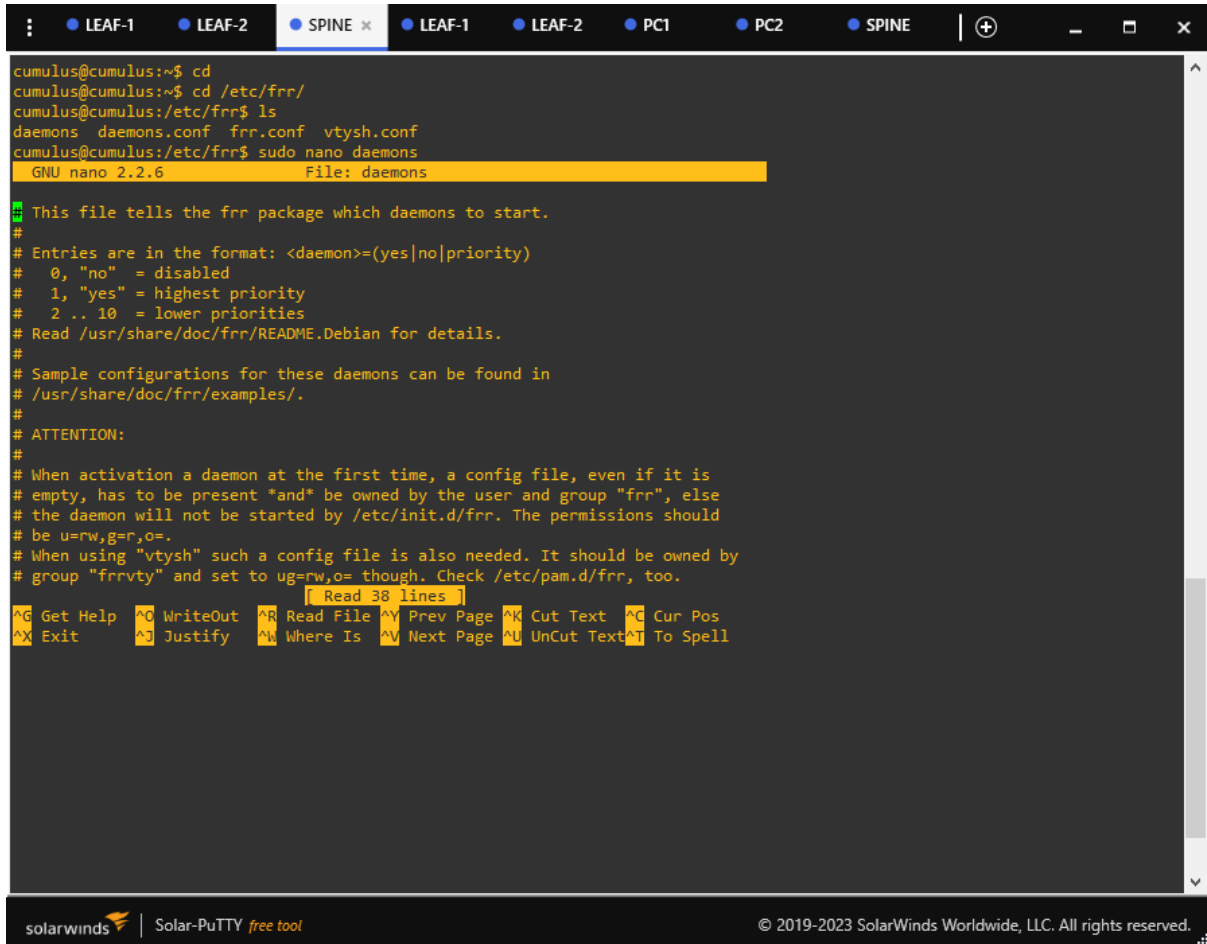
- • net add interface swp1 ip address 5.5.5.2/30
- • net add interface swp2 ip address 7.7.7.2/30
- • net add loopback lo ip address 2.2.2.2/32



Configuración de OSPF, para que OSPF funcione correctamente, es necesario que ciertos servicios estén corriendo en Cumulus Linux, entre ellos FRR:

Para eso ejecutamos:

- `sudo systemctl enable frr.service` (nos va a pedir la password ya que accedemos al root)
- `cd /etc/frr` (direccionamiento a carpeta)
- `ls` (para listar)
- `sudo nano daemon` (para editar el archivo 'daemon')



The screenshot shows a terminal window with a tabbed interface at the top. The active tab is 'SPINE', with other tabs labeled 'LEAF-1', 'LEAF-2', 'PC1', 'PC2', and 'SPINE'. The terminal content shows the user navigating to the /etc/frr directory and opening the 'daemons' file with nano. The file content includes instructions on how to configure daemons, such as setting priorities and permissions. The terminal also shows a status bar at the bottom with 'solarwinds' and 'Solar-PuTTY free tool' logos, and a copyright notice for SolarWinds Worldwide, LLC.

```
cumulus@cumulus:~$ cd
cumulus@cumulus:~$ cd /etc/frr/
cumulus@cumulus:/etc/frr$ ls
daemons  daemons.conf  frr.conf  vtysh.conf
cumulus@cumulus:/etc/frr$ sudo nano daemons
GNU nano 2.2.6      File: daemons

# This file tells the frr package which daemons to start.
#
# Entries are in the format: <daemon>=(yes|no|priority)
# 0, "no" = disabled
# 1, "yes" = highest priority
# 2 .. 10 = lower priorities
# Read /usr/share/doc/frr/README.Debian for details.
#
# Sample configurations for these daemons can be found in
# /usr/share/doc/frr/examples/.
#
# ATTENTION:
#
# When activation a daemon at the first time, a config file, even if it is
# empty, has to be present *and* be owned by the user and group "frr", else
# the daemon will not be started by /etc/init.d/frr. The permissions should
# be u=rw,g=r,o=.
# When using "vtysh" such a config file is also needed. It should be owned by
# group "frrvty" and set to ug=rw,o= though. Check /etc/pam.d/frr, too.

[ Read 38 lines ]
^G Get Help  ^O WriteOut  ^R Read File ^Y Prev Page ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is  ^V Next Page ^U UnCut Text ^T To Spell
```

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Cuando abre el archivo, habilitamos las casillas de 'zebra' y 'ospfd'.



```
GNU nano 2.2.6 File: daemons Modified
# When using "vtysh" such a config file is also needed. It should be owned by
# group "frrvty" and set to ug=rw,o= though. Check /etc/pam.d/frr, too.
#
# The watchfrr daemon is always started. Per default in monitoring-only but
# that can be changed via /etc/frr/daemons.conf.
#
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
isisd=no
pimd=no
ldpd=no
nhrpd=no
eigrpd=no
babeld=no
sharpd=no
Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?
Y Yes
N No ^C Cancel
```

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por ultimo reseteamos el servicio:



```
# When using "vtysh" such a config file is also needed. It should be owned by
# group "frrvty" and set to ug=rw,o= though. Check /etc/pam.d/frr, too.
#
# The watchfrr daemon is always started. Per default in monitoring-only but
# that can be changed via /etc/frr/daemons.conf.
#
zebra=yes
bgpd=no
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
isisd=no
pimd=no
ldpd=no
nhrpd=no
eigrpd=no
babeld=no
sharpd=no

[Wrote 38 lines]

cumulus@cumulus:/etc/frr$ sudo systemctl restart frr.service
cumulus@cumulus:/etc/frr$
```

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```
LEAF-1 LEAF-2 SPINE x LEAF-1 LEAF-2 PC1 PC2 SPINE | + - □ x

cumulus@cumulus:/etc/frr$ sudo systemctl status frr.service
systemctl status frr.service
frr.service - FRRouting
Loaded: loaded (/lib/systemd/system/frr.service; enabled)
Active: active (running) since Tue 2024-03-26 22:32:52 UTC; 39s ago
Process: 1325 ExecStart=/usr/lib/frr/frr start (code=exited, status=0/SUCCESS)
Main PID: 1325
Group: /system.slice/frr.service
CGroup: /system.slice/frr.service
├─1341 /usr/lib/frr/zebra -M snmp -s 900000000 --daemon -A 127.0.0.1
├─1348 /usr/lib/frr/ospfd -M snmp --daemon -A 127.0.0.1
└─1354 /usr/lib/frr/watchfrr -d -r /usr/sbin/serviceb8frrb8restart...

6 22:32:50 cumulus ospfd[1348]: ospfd 4.0+cl3u11 starting: vty@2604
6 22:32:50 cumulus frr[1325]: .
6 22:32:50 cumulus zebra[1341]: client 16 says hello and bids fair to ...es
6 22:32:50 cumulus watchfrr[1354]: watchfrr 4.0+cl3u11 watching [zebra ...]
6 22:32:51 cumulus watchfrr[1354]: zebra state -> up : connect succeeded
6 22:32:51 cumulus watchfrr[1354]: ospfd state -> up : connect succeeded
6 22:32:51 cumulus watchfrr[1354]: Watchfrr: Notifying Systemd we are u...g
6 22:32:51 cumulus frr[1325]: Starting Frr monitor daemon: watchfrr.
6 22:32:52 cumulus frr[1325]: Exiting from the script
6 22:32:52 cumulus systemd[1]: Started FRRouting.
Some lines were ellipsized, use -l to show in full.
cumulus@cumulus:/etc/frr$
```

Configuramos el OSPF en SPINE:

```
LEAF-1 LEAF-2 SPINE x LEAF-1 LEAF-2 PC1 PC2 SPINE | + - □ x

cumulus@cumulus:/etc/frr$ net add ospf router-id 2.2.2.2
cumulus@cumulus:/etc/frr$ net add ospf network 5.5.5.0/30 area 0.0.0.0
cumulus@cumulus:/etc/frr$ net add ospf network 7.7.7.0/30 area 0.0.0.0
cumulus@cumulus:/etc/frr$ net add ospf network 2.2.2.2/32 area 0.0.0.0
cumulus@cumulus:/etc/frr$ net commit
```

LEAF-1LEAF-2SPINE xLEAF-1LEAF-2PC1PC2SPINE

line vty

end

+router ospf

+ ospf router-id 2.2.2.2

+ network 5.5.5.0/30 area 0.0.0.0

+ network 7.7.7.0/30 area 0.0.0.0

+ network 2.2.2.2/32 area 0.0.0.0

+end

net add/del commands since the last "net commit"

=====

User	Timestamp	Command
-----	-----	-----
cumulus	2024-03-26 22:25:19.562649	net add interface swp1 ip address 5.5.5.2/30
cumulus	2024-03-26 22:25:23.534874	net add interface swp2 ip address 7.7.7.2/30
cumulus	2024-03-26 22:25:27.481404	net add loopback lo ip address 2.2.2.2/32
cumulus	2024-03-26 22:34:41.257084	net add ospf router-id 2.2.2.2
cumulus	2024-03-26 22:35:05.678644	net add ospf network 5.5.5.0/30 area 0.0.0.0
cumulus	2024-03-26 22:35:21.112913	net add ospf network 7.7.7.0/30 area 0.0.0.0
cumulus	2024-03-26 22:35:35.734951	net add ospf network 2.2.2.2/32 area 0.0.0.0

cumulus@cumulus:/etc/frr\$

solarwinds Solar-PuTTY free tool

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En LEAF-1:

```
LEAF-1 x LEAF-2 SPINE LEAF-1 LEAF-2 PC1 PC2 SPINE | + - □ x
cumulus@cumulus:~$ net add ospf router-id 1.1.1.1
cumulus@cumulus:~$ net add ospf network 5.5.5.0/30 area 0.0.0.0
cumulus@cumulus:~$ net add ospf network 1.1.1.1/32 area 0.0.0.0
cumulus@cumulus:~$ net commit

```

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```
LEAF-1 x LEAF-2 SPINE LEAF-1 LEAF-2 PC1 PC2 SPINE | + - □ x
bgpd=no
ospfd=no
+ospfd=yes
ospfd=no
ripd=no
ripngd=no
isisd=no
pimd=no
ldpd=no
nhrpd=no
eigrpd=no
babeld=no
sharpd=no
--- /run/nclu/frr/frr.conf.scratchpad.baseline 2024-03-26 22:36:52.392000000 +0000
+++ /run/nclu/frr/frr.conf.scratchpad 2024-03-26 22:37:33.816000000 +0000
@@ -1,9 +1,14 @@
frr version 4.0+cl3u11
frr defaults datacenter
hostname cumulus
username cumulus nopasssword
service integrated-vtysh-config
log syslog informational
line vty

end
+router ospf
+ ospf router-id 1.1.1.1
+ network 5.5.5.0/30 area 0.0.0.0
+ network 1.1.1.1/32 area 0.0.0.0
+end

net add/del commands since the last "net commit"
=====
User      Timestamp      Command
-----
cumulus   2024-03-26 22:36:52.393800 net add ospf router-id 1.1.1.1
cumulus   2024-03-26 22:37:18.869888 net add ospf network 5.5.5.0/30 area 0.0.0.0
cumulus   2024-03-26 22:37:33.816161 net add ospf network 1.1.1.1/32 area 0.0.0.0
cumulus@cumulus:~$

```

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Y en LEAF-2:

The screenshot shows a SolarWinds Solar-PuTTY terminal window with multiple tabs. The active tab is 'LEAF-2'. The terminal displays the following commands and output:

```
cumulus@cumulus:~$ net add ospf router-id 3.3.3.3
'router ospf' configuration already has 'ospf router-id 3.3.3.3'
cumulus@cumulus:~$ net add ospf network 7.7.7.0/30 area 0.0.0.0
cumulus@cumulus:~$ net add ospf network 3.3.3.3/32 area 0.0.0.0
cumulus@cumulus:~$ net commit
```

Below this, the terminal shows the full configuration for the 'router ospf' section, including router-id, network statements, and other OSPF parameters. It also shows the output of the 'net add/del commands since the last "net commit"' command, which lists the commands added to the configuration.

```
isisd=no
pimd=no
ldpd=no
nhrpd=no
eigrpd=no
babeld=no
sharpd=no
--- /run/nclu/frr/frr.conf.scratchpad.baseline 2024-03-26 22:38:55.572000000 +0000
+++ /run/nclu/frr/frr.conf.scratchpad 2024-03-26 22:40:23.961000000 +0000
@@ -1,9 +1,16 @@
 frr version 4.0+cl3u11
 frr defaults datacenter
 hostname cumulus
 username cumulus nopassword
 service integrated-vtysh-config
 log syslog informational
 line vty
 end
+router ospf
+ ospf router-id 1.1.1.1
+ ospf router-id 3.3.3.3
+ network 5.5.5.0/30 area 0.0.0.0
+ network 7.7.7.0/30 area 0.0.0.0
+ network 3.3.3.3/32 area 0.0.0.0
+end

net add/del commands since the last "net commit"
=====
User      Timestamp      Command
-----
cumulus   2024-03-26 22:38:55.574277 net add ospf router-id 1.1.1.1
cumulus   2024-03-26 22:39:05.722470 net add ospf router-id 3.3.3.3
cumulus   2024-03-26 22:39:11.456608 net add ospf router-id 3.3.3.3
cumulus   2024-03-26 22:39:32.109992 net add ospf network 5.5.5.0/30 area 0.0.0.0
cumulus   2024-03-26 22:39:44.058378 net add ospf router-id 3.3.3.3
cumulus   2024-03-26 22:40:12.648155 net add ospf network 7.7.7.0/30 area 0.0.0.0
cumulus   2024-03-26 22:40:23.961986 net add ospf network 3.3.3.3/32 area 0.0.0.0
cumulus@cumulus:~$
```

Ping to LEAF-2, desde LEAF-1, para comprobar que OSPF este funcionando.

```
LEAF-2  SPINE  LEAF-1
cumulus@cumulus:~$ ping 3.3.3.3
PING 3.3.3.3 (3.3.3.3) 56(84) bytes of data.
64 bytes from 3.3.3.3: icmp_seq=1 ttl=63 time=1.55 ms
64 bytes from 3.3.3.3: icmp_seq=2 ttl=63 time=1.33 ms
64 bytes from 3.3.3.3: icmp_seq=3 ttl=63 time=0.836 ms
```

Compruebo la tabla de enrutamiento haciendo: - sudo vtysh y -show ip route

```
LEAF-2  SPINE  LEAF-1
cumulus@cumulus:~$ sudo vtysh
[sudo] password for cumulus:

Hello, this is FRRouting (version 4.0+cl3u11).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

cumulus# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR,
       > - selected route, * - FIB route

O  1.1.1.1/32 [110/0] is directly connected, lo, 20:17:46
C>* 1.1.1.1/32 is directly connected, lo, 20:17:47
O>* 2.2.2.2/32 [110/100] via 5.5.5.2, swp1, 20:17:33
O>* 3.3.3.3/32 [110/200] via 5.5.5.2, swp1, 19:43:08
O  5.5.5.0/30 [110/100] is directly connected, swp1, 20:17:38
C>* 5.5.5.0/30 is directly connected, swp1, 20:17:47
O>* 7.7.7.0/30 [110/200] via 5.5.5.2, swp1, 20:17:33
cumulus#
```

Configurando VLANs: LEAF-1

```
cumulus@cumulus:~$ net add interface swp6 bridge access 10
cumulus@cumulus:~$ net add vlan 10 ip address 10.10.10.5/24
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2024-03-26 22:22:44.223000000 +0000
+++ /run/nclu/ifupdown2/interfaces.tmp  2024-03-27 18:56:45.794000000 +0000
@@ -10,10 +10,26 @@
     address 1.1.1.1/32

# The primary network interface
auto eth0
iface eth0 inet dhcp

auto swp1
iface swp1
    address 5.5.5.1/30

+auto swp6
+iface swp6
+    bridge-access 10
+
+auto bridge
+iface bridge
+    bridge-ports swp6
+    bridge-vids 10
+    bridge-vlan-aware yes
+
+auto vlan10
+iface vlan10
+    address 10.10.10.5/24
+    vlan-id 10
+    vlan-raw-device bridge
+

net add/del commands since the last "net commit"
=====

User      Timestamp                Command
-----
cumulus   2024-03-26 23:14:43.246070 net add ospf router-id 1.1.1.1
```

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LEAF-2:

```
LEAF-2 x SPINE LEAF-1
cumulus@cumulus:~$ clear
cumulus@cumulus:~$ net add interface swp6 bridge access 10
cumulus@cumulus:~$ net add vlan 10 ip address 10.10.10.7/24
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces 2024-03-26 22:24:35.501000000 +0000
+++ /run/ncclu/ifupdown2/interfaces.tmp 2024-03-27 18:58:00.090000000 +0000
@@ -14,10 +14,26 @@
iface eth0 inet dhcp

auto swp1
iface swp1
    address 7.7.7.1/30

auto swp2
iface swp2
    address 7.7.7.1/30

+auto swp6
+iface swp6
+    bridge-access 10
+
+auto bridge
+iface bridge
+    bridge-ports swp6
+    bridge-vids 10
+    bridge-vlan-aware yes
+
+auto vlan10
+iface vlan10
+    address 10.10.10.7/24
+    vlan-id 10
+    vlan-raw-device bridge
+

net add/del commands since the last "net commit"
=====
User      Timestamp      Command
-----
```

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Para que VXLAN LNV (técnica para implementar VLAN sin controlador central) funcione, vxrd tiene que estar corriendo en todos los equipos, hacemos:

- `sudo systemctl start vxrd.service`
- `sudo systemctl status vxrd.service`



The screenshot shows a SolarWinds Solar-PuTTY terminal window with three tabs: LEAF-2, SPINE, and LEAF-1. The active tab is LEAF-2. The terminal output shows the following commands and results:

```
cumulus@cumulus:~$ sudo systemctl start vxrd.service
cumulus@cumulus:~$ sudo systemctl status vxrd.service
● vxrd.service - Lightweight Network Virtualization Peer Discovery Daemon
   Loaded: loaded (/lib/systemd/system/vxrd.service; disabled)
   Active: active (running) since Wed 2024-03-27 18:59:13 UTC; 15s ago
     Main PID: 28408 (vxrd)
    CGroup: /system.slice/vxrd.service
            └─28408 /usr/bin/python /usr/bin/vxrd

Mar 27 18:59:13 cumulus systemd[1]: Started Lightweight Network Virtualizat...n.
Mar 27 18:59:13 cumulus vxrd[28408]: INFO: Starting (pid 28408) ...
Hint: Some lines were ellipsized, use -l to show in full.
cumulus@cumulus:~$
```

The bottom of the window shows the SolarWinds logo and the text "Solar-PuTTY free tool" on the left, and the copyright notice "© 2019-2023 SolarWinds Worldwide, LLC. All rights reserved." on the right.

Configuración de Service Node Functionality en SPINE:

```
cumulus@cumulus:~$ clear
cumulus@cumulus:~$ net add lnv service-node source 2.2.2.2
cumulus@cumulus:~$ net add lnv service-node anycast-ip 2.2.2.2
cumulus@cumulus:~$ net commit
--- /etc/vxsnd.conf      2018-09-05 05:02:09.000000000 +0000
+++ /run/nclu/lnv/etc_vxsnd_conf_scratchpad      2024-03-27 19:00:17.711000000 +0000
@@ -15,29 +15,29 @@
#pidfile = /var/run/vxsnd.pid

# The file name for the unix domain socket used for mgmt.
#udsfile = /var/run/vxsnd.sock

# UDP port for vxfld control messages
#vxfld_port = 10001

# This is the address to which registration daemons send control messages for
# registration and/or BUM packets for replication
-#svcnode_ip = 0.0.0.0
+svcnode_ip = 2.2.2.2

# Holdtime (in seconds) for soft state. It is used when sending a
# register msg to peers in response to learning a <vni, addr> from a
# VXLAN data pkt
#holdtime = 90

# Local IP address to bind to for receiving inter-vxsnd control traffic
-#src_ip = 0.0.0.0
+src_ip = 2.2.2.2

[vxsnd]
# Space separated list of IP addresses of vxsnd to share state with
#svcnode_peers =

# When set to true, the service node will listen for vxlan data traffic
# Note: Use 1, yes, true, or on, for True and 0, no, false, or off,
# for False
#enable_vxlan_listen = true
```

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En LEAF-1:

```
LEAF-2 SPINE LEAF-1
cumulus@cumulus:~$ net add loopback lo vxrd-src-ip 1.1.1.1
cumulus@cumulus:~$ net add loopback lo vxrd-svcnode-ip 2.2.2.2
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2024-03-27 18:56:46.402000000 +0000
+++ /run/ncclu/ifupdown2/interfaces.tmp 2024-03-27 19:01:27.217000000 +0000
@@ -1,20 +1,22 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*.intf

# The loopback network interface
auto lo
iface lo inet loopback
    # The primary network interface
    address 1.1.1.1/32
+   vxrd-src-ip 1.1.1.1
+   vxrd-svcnode-ip 2.2.2.2

# The primary network interface
auto eth0
iface eth0 inet dhcp

auto swp1
iface swp1
    address 5.5.5.1/30

auto swp6

net add/del commands since the last "net commit"
=====
User      Timestamp                Command
-----
cumulus   2024-03-27 19:01:06.780646 net add loopback lo vxrd-src-ip 1.1.1.1
cumulus   2024-03-27 19:01:23.364249 net add loopback lo vxrd-svcnode-ip 2.2.2.2
cumulus@cumulus:~$
```

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En LEAF-2:

```
LEAF-2 SPINE LEAF-1
cumulus@cumulus:~$ net add loopback lo vxrd-src-ip 3.3.3.3
cumulus@cumulus:~$ net add loopback lo vxrd-svcnode-ip 2.2.2.2
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2024-03-27 18:58:00.452000000 +0000
+++ /run/nclu/ifupdown2/interfaces.tmp 2024-03-27 19:02:21.088000000 +0000
@@ -1,20 +1,22 @@
# This file describes the network interfaces available on your system
# and how to activate them. For more information, see interfaces(5).

source /etc/network/interfaces.d/*.intf

# The loopback network interface
auto lo
iface lo inet loopback
    # The primary network interface
    address 3.3.3.3/32
+   vxrd-src-ip 3.3.3.3
+   vxrd-svcnode-ip 2.2.2.2

# The primary network interface
auto eth0
iface eth0 inet dhcp

auto swp1
iface swp1
    address 7.7.7.1/30

auto swp2

net add/del commands since the last "net commit"
=====
User      Timestamp                Command
-----
cumulus   2024-03-27 19:02:02.700543 net add loopback lo vxrd-src-ip 3.3.3.3
cumulus   2024-03-27 19:02:17.756380 net add loopback lo vxrd-svcnode-ip 2.2.2.2
cumulus@cumulus:~$
```

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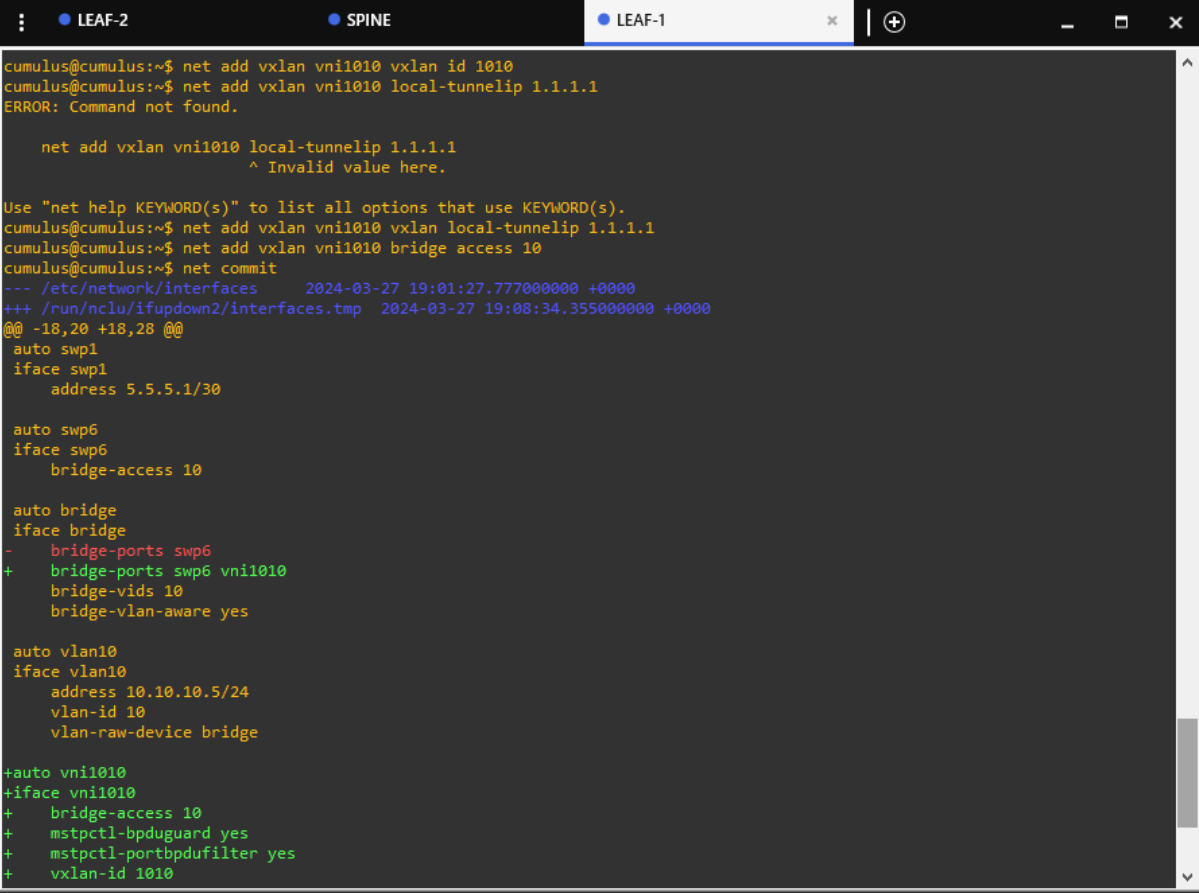
Mapeo VLAN-VXLAN en VTEP: Configuración de la VLAN 10 para vincularse con el VNID 1010.

Explicación:

Los VTEP son como los “guardianes” que traducen entre las VLAN y las VXLAN.

Configuramos una tabla que dice: “La VLAN 10 se traduce al VNID 1010”. Así, los datos de la VLAN 10 pueden viajar por la red VXLAN usando ese VNID.

En LEAF-1:



```
cumulus@cumulus:~$ net add vxlan vni1010 vxlan id 1010
cumulus@cumulus:~$ net add vxlan vni1010 local-tunnelip 1.1.1.1
ERROR: Command not found.

net add vxlan vni1010 local-tunnelip 1.1.1.1
      ^ Invalid value here.

Use "net help KEYWORD(s)" to list all options that use KEYWORD(s).
cumulus@cumulus:~$ net add vxlan vni1010 vxlan local-tunnelip 1.1.1.1
cumulus@cumulus:~$ net add vxlan vni1010 bridge access 10
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2024-03-27 19:01:27.777000000 +0000
+++ /run/ncnu/ifupdown2/interfaces.tmp 2024-03-27 19:08:34.355000000 +0000
@@ -18,20 +18,28 @@
 auto swp1
 iface swp1
     address 5.5.5.1/30

 auto swp6
 iface swp6
     bridge-access 10

 auto bridge
 iface bridge
 -   bridge-ports swp6
 +   bridge-ports swp6 vni1010
     bridge-vids 10
     bridge-vlan-aware yes

 auto vlan10
 iface vlan10
     address 10.10.10.5/24
     vlan-id 10
     vlan-raw-device bridge

+auto vni1010
+iface vni1010
+   bridge-access 10
+   mstpctl-bpdguard yes
+   mstpctl-portbpdfilter yes
+   vxlan-id 1010
```

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En LEAF-2:

```
LEAF-2  SPINE  LEAF-1
cumulus@cumulus:~$ clear
cumulus@cumulus:~$ net add vxlan vni1010 vxlan id 1010
cumulus@cumulus:~$ net add vxlan vni1010 vxlan local-tunnelip 3.3.3.3
cumulus@cumulus:~$ net add vxlan vni1010 vxlan remoteip 1.1.1.1
cumulus@cumulus:~$ net add vxlan vni1010 bridge access 10
cumulus@cumulus:~$ net commit
--- /etc/network/interfaces      2024-03-27 19:02:21.406000000 +0000
+++ /run/ncLU/ifupdown2/interfaces.tmp  2024-03-27 19:05:52.685000000 +0000
@@ -22,20 +22,29 @@
 auto swp2
 iface swp2
     address 7.7.7.1/30

 auto swp6
 iface swp6
     bridge-access 10

 auto bridge
 iface bridge
 -     bridge-ports swp6
 +     bridge-ports swp6 vni1010
     bridge-vids 10
     bridge-vlan-aware yes

 auto vlan10
 iface vlan10
     address 10.10.10.7/24
     vlan-id 10
     vlan-raw-device bridge

+auto vni1010
+iface vni1010
+    bridge-access 10
+    mstpctl-bpduguard yes
+    mstpctl-portbpdudfilter yes
+    vxlan-id 1010
+    vxlan-local-tunnelip 3.3.3.3
+    vxlan-remoteip 1.1.1.1
+
```

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Comprobación de Conectividad de extremos a extremo:

Configuración de vPC-1:

Vamos a la consola de la PC-1, y ejecutamos:

- ip 10.10.10.10/24



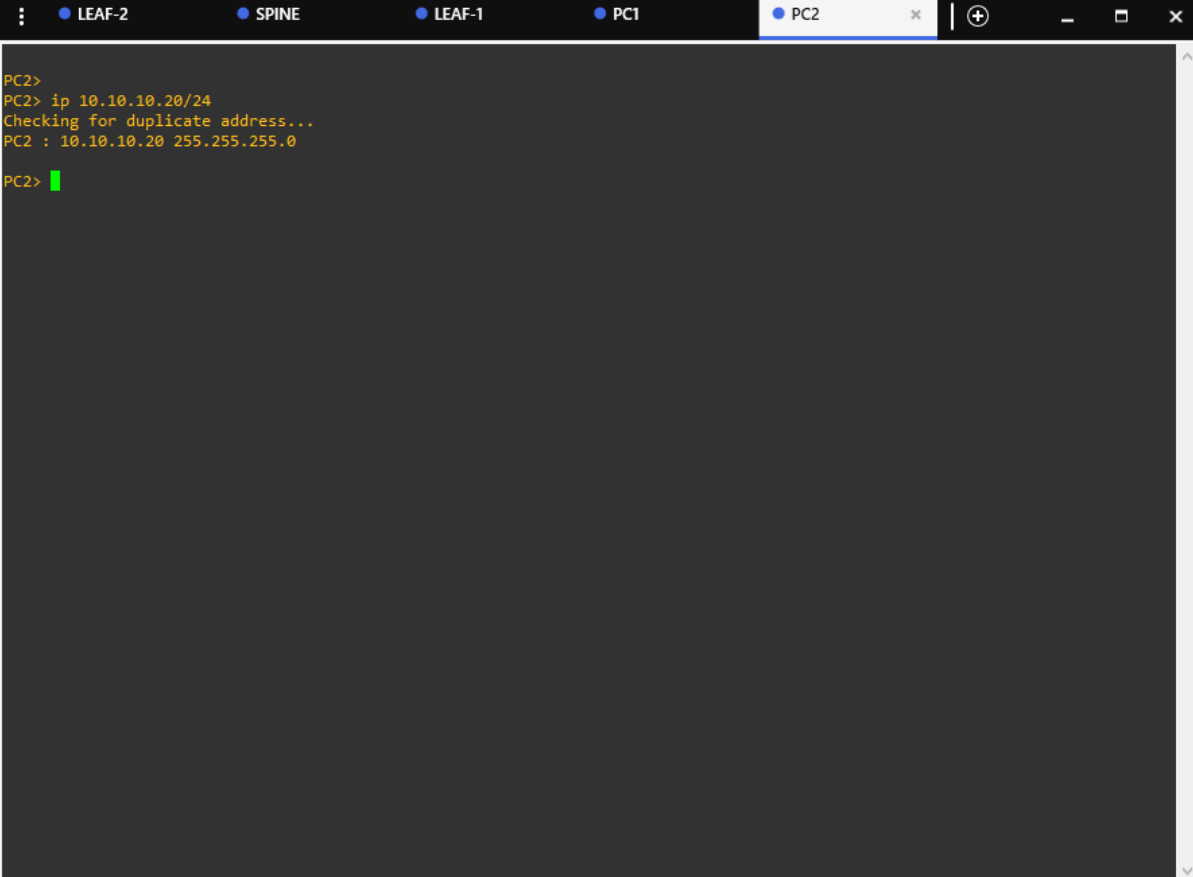
The screenshot shows a SolarWinds Solar-PuTTY terminal window with a dark background. The top bar contains tabs for LEAF-2, SPINE, LEAF-1, PC1 (selected), and PC2. The terminal output for PC1 is as follows:

```
PC1>  
PC1>  
PC1>  
PC1> ip 10.10.10.10/24  
Checking for duplicate address...  
PC1 : 10.10.10.10 255.255.255.0  
  
PC1> █
```

The bottom status bar displays the SolarWinds logo, the text "Solar-PuTTY free tool", and the copyright notice "© 2019-2023 SolarWinds Worldwide, LLC. All rights reserved."

Lo mismo con la PC-2, pero ejecutamos:

- ip 10.10.10.20/24



The screenshot shows a SolarWinds Solar-PuTTY terminal window with a dark background. The title bar at the top contains tabs for LEAF-2, SPINE, LEAF-1, PC1, and PC2, with PC2 being the active tab. The terminal displays the following text:

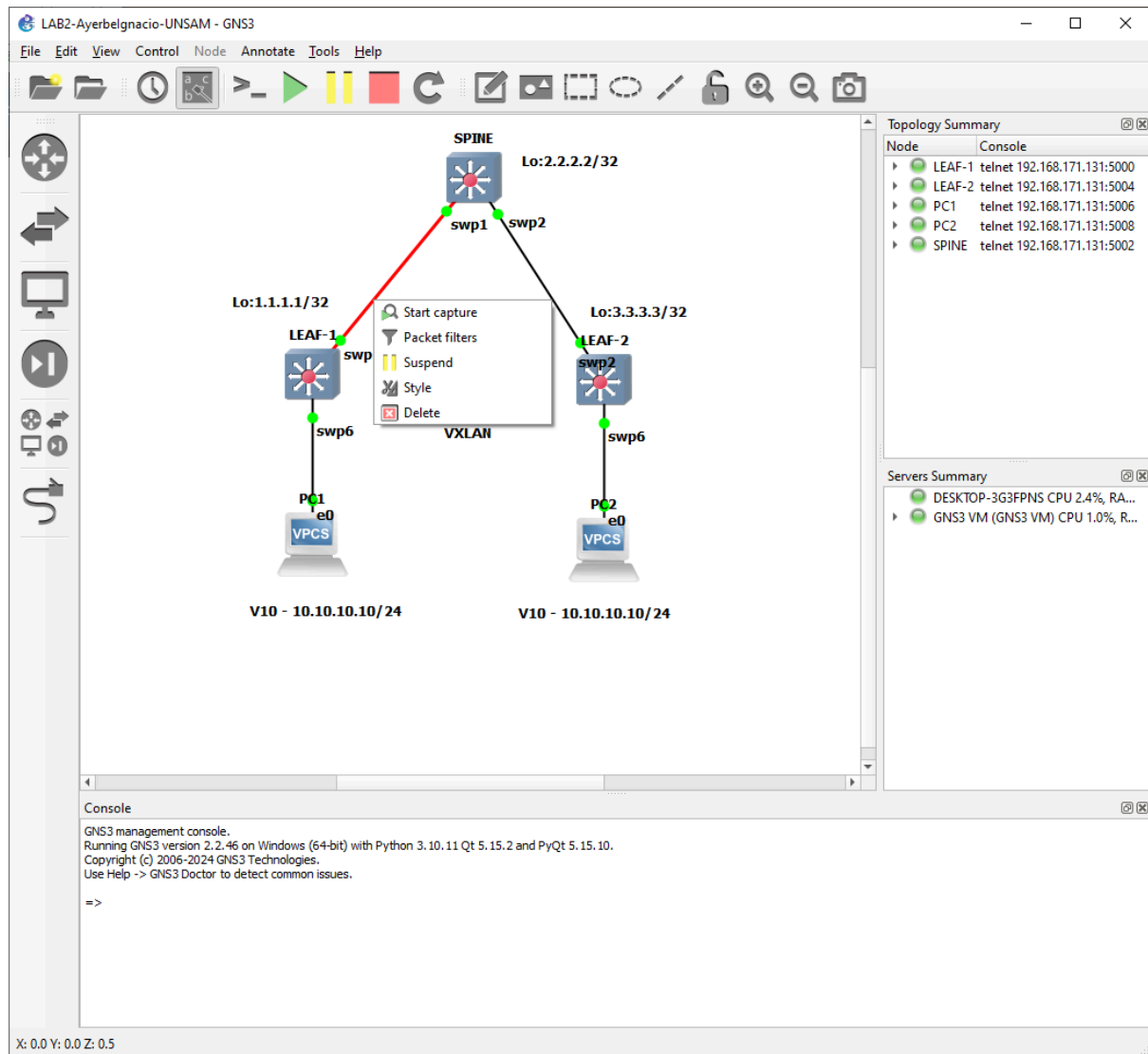
```
PC2>  
PC2> ip 10.10.10.20/24  
Checking for duplicate address...  
PC2 : 10.10.10.20 255.255.255.0  
PC2> █
```

The bottom status bar of the window shows the SolarWinds logo, the text "Solar-PuTTY free tool", and the copyright notice "© 2019-2023 SolarWinds Worldwide, LLC. All rights reserved."

Lo que hicimos fue conectar las PCs entre sí dentro de la misma VLAN y bajo la misma subred IP. Ya que le estamos asignando la misma máscara subred de 24 bits (255.255.255.0), con diferentes direcciones IP cada una, les permite comunicarse entre sí.

Captura con Wireshark:

click secundario sobre el enlace que une a LEAF-1 y SPINE, y selecciono 'Start Capture'



En las peticiones ARP o ICMP, se observa la encapsulación adicional de VXLAN con el VNID 1010

Capturando desde - [LEAF-1 swp1 to SPINE swp1]

Archivo Edición Visualización Ir Captura Analizar Estadísticas Telefonía Wireless Herramientas Ayuda

Aplique un filtro de visualización ... <Ctrl-/>

No.	Time	Source	Destination	Protocol	Length	Info
28	78.438857	1.1.1.1	2.2.2.2	UDP	73	10001 → 10001 Len=31
29	78.440041	2.2.2.2	1.1.1.1	UDP	77	10001 → 10001 Len=35
30	81.468669	5.5.5.2	224.0.0.5	OSPF	82	Hello Packet
31	85.370702	5.5.5.1	224.0.0.5	OSPF	82	Hello Packet
32	89.255550	0c:4d:ef:e0:00:01	LLDP_Multicast	LLDP	308	MA/0c:4d:ef:e0:00:00 IN/s
33	89.256240	0c:f0:21:bf:00:01	LLDP_Multicast	LLDP	308	MA/0c:f0:21:bf:00:00 IN/s
34	90.430035	0c:f0:21:bf:00:06	Broadcast	ARP	92	Who has 10.10.10.10? Tell
35	91.396452	5.5.5.2	224.0.0.5	OSPF	82	Hello Packet
36	95.309159	5.5.5.1	224.0.0.5	OSPF	82	Hello Packet
37	101.357363	5.5.5.2	224.0.0.5	OSPF	82	Hello Packet

< >

> Frame 34: 92 bytes on wire (736 bits), 92 bytes captured (736 bits) on interface
 > Ethernet II, Src: 0c:f0:21:bf:00:01 (0c:f0:21:bf:00:01), Dst: 0c:4d:ef:e0:00:01
 > Internet Protocol Version 4, Src: 1.1.1.1, Dst: 3.3.3.3
 > User Datagram Protocol, Src Port: 33675, Dst Port: 4789
 > Virtual eXtensible Local Area Network
 > Flags: 0x0800, VXLAN Network ID (VNI)
 Group Policy ID: 0
 VXLAN Network Identifier (VNI): 1010
 Reserved: 0
 > Ethernet II, Src: 0c:f0:21:bf:00:06 (0c:f0:21:bf:00:06), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
 > Address Resolution Protocol (request)

0000 0c 4d ef e0 00 01
 0010 00 4e 14 b4 00 00
 0020 03 03 83 8b 12 b5
 0030 f2 00 ff ff ff ff
 0040 00 01 08 00 06 04
 0050 0a 05 00 00 00 00

Preparado para cargar o capturar || Paquetes: 37 · Mostrado: 37 (100.0%) || Perfil: Default

Se puede ver cada VTEP, en las direcciones MACs de LEAF-1, ejecutando:

- net show bridge macs

Esto nos muestra que, en el LEAF-1 se ha aprendido la MAC del LEAF-2, a través de la VNI 1010, a pesar de estar en otro lugar físico y separado por diferentes IPs.



```
cumulus@cumulus:~$ net show bridge macs
```

VLAN	Master	Interface	MAC	TunnelDest	State	Flags	LastSeen
10	bridge	bridge	0c:f0:21:bf:00:06		permanent		00:25:39
10	bridge	swp6	00:50:79:66:68:00				00:01:14
10	bridge	vni1010	00:50:79:66:68:01				00:00:29
10	bridge	vni1010	0c:84:3f:83:00:06				00:03:33
untagged		vni1010	00:00:00:00:00:00	3.3.3.3	permanent	self	00:13:50
untagged		vni1010	00:50:79:66:68:01	3.3.3.3		self	00:04:10
untagged		vni1010	0c:84:3f:83:00:06	3.3.3.3		self	00:04:44
untagged	bridge	swp6	0c:f0:21:bf:00:06		permanent		00:25:39
untagged	bridge	vni1010	3e:ef:cf:d7:60:b1		permanent		00:13:50

```
cumulus@cumulus:~$
```

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