S5.B.01 Infrastructure Evolution

Phase 2: Network and Basic Services (Application)

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Contents

Introduction

After the first phase, we are now ready to set up the network for Trisomie21. After being introduced to the environment by Mr. Kandi, we chose to follow these steps. First, we wrote scripts for all the routers and switches to set up IPv4 and IPv6. After this, we set up the server with DHCP and DNS, then we set up the ACL and finished by installing services on employee computers and VLANs for managers and employees.

Infrastructure

The first step of the second phase consisted of the installation of the network topology and of the configuration of the hardware.

We started this step by learning how to create scripts for CISCO routers/switches and found out it's pretty easy. You just need to copy-paste all the commands you want to type at once. So, we started by creating a simple script for each router one by one, and for each one, we set the IP addresses for interfaces and the OSPF/BGP configurations. We tested everything on CISCO Packet Tracer. Then, the next day, we went to the room with all the equipment to test it for real. After configuring everything, we encountered a problem where some connections didn't work. We concluded that several ports on almost all routers were down, and we had to find a new solution to avoid this problem. After trying different topologies, Mr. Kandi gave everyone the same one so we could all work on it. After this issue, we had to rewrite all the scripts.

Topology

The first step of the second phase was setting up the routers and switches, by following the topology previously established. Because of some technical issue, the original topology suffered some modifications. First, the serial ports of most of the routers were dysfunctional, we had to use a switch in order to implement the inter-vlan routing, to preserve the redundancy.

IP addressing

We chose to elaborate a new ip addressing plan, mainly because the previous one was quite messy, and the new one will be more coherent.

vlan

The infrastructure will include different vlan (virtual network), that can answer to different situation.

- Inter vlan routing : Because of the lack of serial port, we had to replace a connection between different router by a switch, and this came with different issue, like putting 2 différents network oon the same physical connection. To answer that issue, we chose to implement inter vlan routing, for this, this include creating a vlan for each network (15 for the netwrk 10.3.0.0 and 25 for the network 10.2.0.0). The mode is "trunk" on the interface connected to the router 3 and "access" for the others interfaces. The intervlan routing also need us to create two subinterface on the router 3, who will be acting like theres physical interfaces.

Zone			
	Nom	**Adress IP**	**mask**
Site principale			
	Routeur 0	10.0.0.1 2001:0::1/64 10.6.0.1 2001:6::1/64 192.168.11.254 2001:11::1/64 192.168.12.254 2001:12::1/64 192.168.13.254 2001:13::1/64	255.255.255.252 255.255.255.252 255.255.255.0 255.255.255.0
	Serveur	192.168.11.3 | 2001:11::3/64	255.255.255.0
	Switch 10	vlan 10 (192.168.11.0 /25) vlan 20 (192.168.12.0 /25) vlan 30 (192.168.13.0 /25)	255.255.255.0
	Switch 8	vlan 20 (192.168.12.0 /25) vlan 30 (192.168.13.0 /25)	255.255.255.0
	Switch 7	vlan 20 (192.168.12.0 /25) vlan 30 (192.168.13.0 /25)	255.255.255.0

Figure 1: Main site

Site 1			
	Router 1	10.7.0.1 2001:7::1/64 192.168.22.254 2001:22::1/64 192.168.23.254 2001:23::1/64	255.255.255.252 255.255.255.0 255.255.255.0
	Switch	vlan 20 | vlan 30	
	Switch	vlan 20 | vlan 30	
	Switch	vlan 20 | vlan 30	

Figure 2: Site 1

Site 2			
	Router 2	10.6.0.2 2001:6::2/64 192.168.32.254 2001:32::1/64 192.168.33.254 2001:33::1/64	255.255.255.252 255.255.255.0 255.255.255.0
	Switch	vlan 20 (192.168.22.0 /25) vlan 30 (192.168.23.0 /25)	255.255.255.0
	Switch	vlan 20 (192.168.22.0 /25) vlan 30 (192.168.23.0 /25)	255.255.255.0
	Switch	vlan 20 (192.168.22.0 /25) vlan 30 (192.168.23.0 /25)	255.255.255.0

Figure 3: Site 2

WAN			
	Routeur 3	10.3.0.2 2001:3::2/64 10.2.0.2 2001:2::2/64 10.0.0.2 2001:0::2/64 10.1.0.2 2001:1::1/64	255.255.255.252
	Router 4	10.7.0.2 2001:7::2/64 10.2.0.1 2001:2::1/64 10.4.0.1 2001:4::1/64	255.255.255.252
	Routeur 5	10.4.0.2 2001:4::2/64 10.5.0.1 2001:5::1/64 10.1.0.1 2001:1::2/64	255.255.255.252
	Router 6	10.3.0.1 2001:3::1/64 10.5.0.2 2001:5::2/64	255.255.255.252
	Switch 9	vlan 15 (10.2.0.0 /30) vlan 25 (10.3.0.0.1/30)	255.255.255.252

Figure 4: WAN

- On site VLAN : The network traffics need to be divided in two, for the responsables and the members. For this, we will use 2 vlan on each site, vlan 20 for the responsable and vlan 30 for the members.

Router and Switch Configuration

This section will contain all the scripts used to configure the switches and the routers. These scripts permit us to set up quickly the configuration of the routers, they can be used juste by being copied on the router terminal.

Router configuration

All the routers configuration commands. The scripts are just basics cisco commands put together, including interface (ip and ipv6) configuration, OSPF protocol configuration, BGP protocol configuration for the router 0 and 2.

Listing 1: router 0

```
enable
configure terminal

interface gigabitethernet 0/0
ip address 10.0.0.1 255.255.255.252
ip helper-address 192.168.11.3
no shutdown
ipv6 address 2001:0::1/64
ipv6 enable

exit



interface gigabitethernet 0/1
ip address 10.6.0.1 255.255.255.252
ip helper-address 192.168.11.3
no shutdown
ipv6 address 2001:6::1/64
ipv6 enable

exit

interface gigabitethernet 0/2
no shutdown
ipv6 enable
exit

interface gigabitethernet 0/2.10
encapsulation dot1q 10
ip address 192.168.11.254 255.255.255.252
ip helper-address 192.168.11.3
```

```
exit

interface gigabitethernet 0/2.20
encapsulation dot1q 20
ip address 192.168.12.254 255.255.255.252
ip helper-address 192.168.11.3
exit

interface gigabitethernet 0/2.30
encapsulation dot1q 30
ip address 192.168.13.254 255.255.255.252
ip helper-address 192.168.11.3
exit

router ospf 1
network 10.0.0.0 0.0.0.3 area 0
network 192.168.11.0 0.0.0.255 area 0
network 192.168.12.0 0.0.0.255 area 0
network 192.168.13.0 0.0.0.255 area 0
network 10.6.0.0 0.0.0.255 area 0

ipv6 unicast-routing
ipv6 router ospf 2
exit

interface gigabitethernet 0/0
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/1
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/2.10
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/2.20
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/2.30
ipv6 ospf 2 area 0
exit

router bgp 64998
neighbor 10.6.0.2 remote-as 64999
address-family ipv6
neighbor 2001:6::2/64 activate
```

```
neighbor 2001:6::2/64 remote-as 64999
exit

address-family ipv4
network 10.6.0.0
exit

address-family ipv6
network 2001:6::/64

exit

exit

exit
!
```

Listing 2: router 1

```
enable
configure terminal

interface gigabitethernet 0/1
ip address 10.7.0.1 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:7::1/64
no shutdown
exit

interface gigabitethernet 0/0
no shutdown
exit

interface gigabitethernet 0/0.20
encapsulation dot1q 20
ip address 192.168.22.254 255.255.255.0
ip helper-address 192.168.11.3
ipv6 address 2001:22::1/64
ipv6 enable
exit

interface gigabitethernet 0/0.30
encapsulation dot1q 30
ip address 192.168.23.254 255.255.255.0
ip helper-address 192.168.11.3
ipv6 address 2001:23::1/64
ipv6 enable
exit
```

```
router ospf 1
network 10.7.0.0 0.0.0.3 area 0
network 192.168.22.0 0.0.0.255 area 0
network 192.168.23.0 0.0.0.255 area 0
exit

ipv6 unicast-routing

ipv6 router ospf 2
 router-id 1.1.1.1

interface gigabitethernet 0/0.20
 ipv6 ospf 2 area 0

interface gigabitethernet 0/0.30
 ipv6 ospf 2 area 0

interface gigabitethernet 0/1
 ipv6 ospf 2 area 0

exit
exit
exit
!
```

Listing 3: router 2

```
enable
configure terminal

interface gigabitethernet 0/1
description LAN IPv4
ip address 10.6.0.2 255.255.255.252
ip helper-address 192.168.11.3
no shutdown
description LAN IPv6
ipv6 address 2001:6::2/64
no shutdown
exit

interface gigabitethernet 0/0
no shutdown
exit

interface gigabitethernet 0/0.20
encapsulation dot1q 20
ip address 192.168.32.254 255.255.255.0
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:32::1/64
```

```
exit

interface gigabitethernet 0/0.30
encapsulation dot1q 30
ip address 192.168.33.254 255.255.255.0
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:33::1/64
exit

router ospf 1
router-id 2.2.2.2
network 192.168.32.0 0.0.0.255 area 0
network 10.6.0.0 0.0.0.3 area 0
network 192.168.33.0 0.0.0.255 area 0
ipv6 unicast-routing
ipv6 router ospf 2
exit

interface gigabitethernet 0/0
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/1.20
ipv6 ospf 2 area 0
exit

interface gigabitethernet 0/1.30
ipv6 ospf 2 area 0
exit

router bgp 64999
neighbor 10.6.0.1 remote-as 64998
address-family ipv6
neighbor 2001:6::1/64 activate
neighbor 2001:6::1/64 remote-as 64998
exit

address-family ipv4
network 10.6.0.0
network 192.168.32.0
network 192.168.33.0
exit

address-family ipv6
network 2001:6::/64
exit

exit
```

```
exit
```

Listing 4: router 3

```
enable
conf t

interface gigabitethernet0/0
no shutdown
exit

interface gigabitethernet0/0.15
encapsulation dot1q 15
ip address 10.3.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:3::2/64
exit

interface gigabitethernet0/0.25
encapsulation dot1q 25
ip address 10.2.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:2::2/64
exit


interface gigabitethernet 0/1
ip address 10.0.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:0::2/64
no shutdown
exit


interface gigabitethernet 0/2
ip address 10.1.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:1::1/64
no shutdown
exit


router ospf 1
network 10.4.0.0 0.0.0.3 area 0
network 10.0.0.0 0.0.0.3  area 0
```

```
network 10.1.0.0 0.0.0.3  area 0
network 10.2.0.0 0.0.0.3  area 0
network 10.3.0.0 0.0.0.3  area 0
exit

ipv6 unicast-routing
ipv6 router ospf 2
router-id 3.3.3.3

interface gigabitethernet 0/0
ipv6 ospf 2 area 0

interface gigabitethernet 0/0.15
ipv6 ospf 2 area 0

interface gigabitethernet 0/0.25
ipv6 ospf 2 area 0


interface gigabitethernet 0/1
ipv6 ospf 2 area 0

interface gigabitethernet 0/2
ipv6 ospf 2 area 0


exit
exit
exit
!
```

Listing 5: router 4

```
enable
config t
interface gigabitethernet 0/0
ip address 10.7.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:7::2/64
no shutdown
exits


interface gigabitethernet 0/1
ip address 10.2.0.1 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:2::1/64
no shutdown
```

```
exit

interface gigabitethernet 0/2
ip address 10.4.0.1 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:4::1/64
no shutdown
exit


router ospf 1
network 10.7.0.0 0.0.0.3 area 0
network 10.4.0.0 0.0.0.3 area 0
network 10.2.0.0 0.0.0.3 area 0
exit

ipv6 unicast-routing
ipv6 router ospf 2
router-id 4.4.4.4

interface gigabitethernet 0/0
ipv6 ospf 2 area 0


interface gigabitethernet 0/1
ipv6 ospf 2 area 0

interface gigabitethernet 0/2
ipv6 ospf 2 area 0

exit

exit
exit
!
```

Listing 6: router 5

```
enable
config t

interface gigabitethernet 0/0
ip address 10.4.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:4::2/64
no shutdown
exit
```

```
interface gigabitethernet 0/1
ip address 10.5.0.1 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:5::1/64
no shutdown
exit

interface gigabitethernet 0/2
ip address 10.1.0.1 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:1::2/64
no shutdown
exit


router ospf 1
network 10.4.0.0 0.0.0.3 area 0
network 10.5.0.0 0.0.0.3 area 0
network 10.1.0.0 0.0.0.3 area 0

exit


ipv6 unicast-routing
ipv6 router ospf 2
router-id 5.5.5.5

interface gigabitethernet 0/0
ipv6 ospf 2 area 0

interface gigabitethernet 0/1
ipv6 ospf 2 area 0

interface gigabitethernet 0/2
ipv6 ospf 2 area 0

exit
exit
exit
!
```

Listing 7: Router 6

```
enable
config t
interface FastEthernet 0/0
ip address 10.3.0.1 255.255.255.252
ip helper-address 192.168.11.3
```

```
ipv6 enable
ipv6 address 2001:3::1/64
no shutdown
exit

interface FastEthernet 0/1
ip address 10.5.0.2 255.255.255.252
ip helper-address 192.168.11.3
ipv6 enable
ipv6 address 2001:5::2/64
no shutdown
exit


router ospf 1
network 10.3.0.0 0.0.0.3 area 0
network 10.5.0.0 0.0.0.3 area 0
exit

ipv6 unicast-routing
ipv6 router ospf 2
router-id 6.6.6.6

interface FastEthernet0/0
ipv6 ospf 2 area 0

interface FastEthernet0/1
ipv6 ospf 2 area 0

exit

exit

exit
!
```

Switches

All the switches configuration commands. The scripts are just basics cisco commands put together, including vlan and mode (trunk or access) configuration. Switches 6, 3 and 0 all have a specifics configuration to separate the vlan between the others switches, as well as switch 9, used to set up the intervlan routing in the WAN. All the others switches have the same configuration.

Listing 8: switch 9

```
en
conf t
vlan 15
name VLAN15
```

```
vlan 25
name VLAN25

interface fastethernet0/2
switchport mode access
switchport access vlan 15
exit

interface fastethernet0/3
switchport mode access
switchport access vlan 25
exit

interface fastethernet0/1
switchport mode trunk
exit
```

Listing 9: switch 6

```
en
conf t

interface Fa0/1
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/2
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/3
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/4
switchport mode access
switchport access vlan 10
exit

interface range Fa0/5-24
switchport mode access
switchport access vlan 20
exit

interface range Fa0/25-48
switchport mode access
switchport access vlan 30
```

```
exit
exit
!
```

Listing 10: switches 0 and 3

```
en
conf t

interface Fa0/1
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/2
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/3
switchport trunk encapsulation dot1q
switchport mode trunk
exit


interface range Fa0/4-24
switchport mode access
switchport access vlan 20
exit

interface range Fa0/25-48
switchport mode access
switchport access vlan 30
exit
exit
!
```

Listing 11: All remaining switches

```
en
conf t

interface Fa0/1
switchport trunk encapsulation dot1q
switchport mode trunk
exit

interface Fa0/2
switchport trunk encapsulation dot1q
switchport mode trunk
exit
```

```
interface Fa0/3
switchport trunk encapsulation dot1q
switchport mode trunk
exit


interface range Fa0/4-24
switchport mode access
switchport access vlan 20
exit

interface range Fa0/25-48
switchport mode access
switchport access vlan 30
exit
exit
!
```

Service

DHCP

In order to set up a DHCP server, we used the docker dhcpd/networkboot from dockerhub, with our own configuration file.

commands

- **Pull** the docker image : docker pull networkboot/dhcpd
- **Create** the /data folder : mkdir /data
- **Create** the dhcpd.conf file : nano dhcpd.conf
- **Launch** the docker with the following command : sudo docker run -it –rm –init –net host -v "$(pwd)/data/":/data networkboot/dhcpd enp2s0

Configuration file

The dhcpd.conf file contain the different subnet, allowing all the machines to get an ip address.

Listing 12: Routeur 0 et 2

```
subnet 192.168.11.0 netmask 255.255.255.0 {

}

subnet 192.168.12.0 netmask 255.255.255.0 {
  range 192.168.12.1 192.168.12.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.12.254;
  default-lease-time 600;
  max-lease-time 7200;
}


subnet 192.168.2.0 netmask 255.255.255.0 {
  range 192.168.2.1 192.168.2.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.2.254;
```

```
  default-lease-time 600;
  max-lease-time 7200;
}


subnet 192.168.13.0 netmask 255.255.255.0 {
  range 192.168.13.1 192.168.13.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.13.254;
  default-lease-time 600;
  max-lease-time 7200;
}

subnet 192.168.22.0 netmask 255.255.255.0 {
  range 192.168.22.1 192.168.22.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.22.254;
  default-lease-time 600;
  max-lease-time 7200;
}

subnet 192.168.23.0 netmask 255.255.255.0 {
  range 192.168.23.1 192.168.23.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.23.254;
  default-lease-time 600;
  max-lease-time 7200;
}

subnet 192.168.32.0 netmask 255.255.255.0 {
  range 192.168.32.1 192.168.32.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.32.254;
  default-lease-time 600;
  max-lease-time 7200;
}

subnet 192.168.33.0 netmask 255.255.255.0 {
  range 192.168.33.1 192.168.33.253;
  option subnet-mask 255.255.255.0;
  option routers 192.168.33.254;
  default-lease-time 600;
  max-lease-time 7200;
}
```

WEB SERVER

The web server allows all users to access the trisomie21 website. We used **apache2**, because of the high performance, flexibility and a lot of documentation.

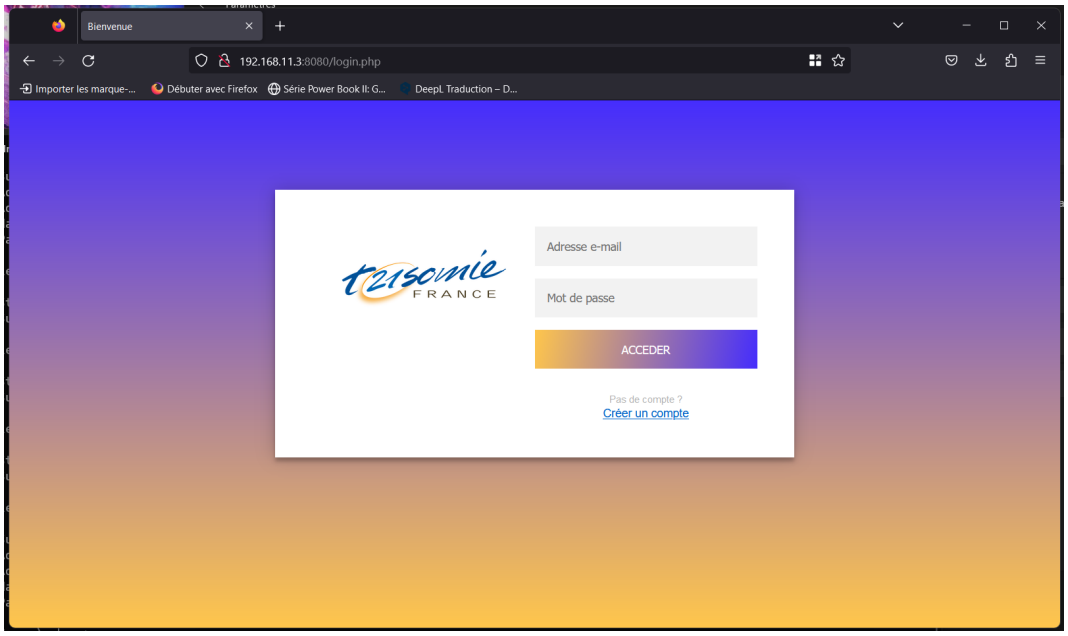

Figure 5: Web server login page

We used the official httpd image.

commands

- **Pull** the docker image : docker pull httpd
- **Create** the /public-html folder : mkdir /public-htmll
- **Put** the website file in the /public-html folder
- **Edit** the Dockerfile with the following configuration:

```
FROM httpd:2.4
COPY ./public-html/ /usr/local/apache2/htdocs/
```

- Launch the docker with the following command : "sudo docker run -dit –name trisomie21$_{w}ebsite-p8080:80my-apache2$"

DNS

The DNS was almost ready but we didnt want to risk a DHCP issue by implementing it during the last hour, so we just get the configuration ready for our next phase.

Configuration

We were planning to use the docker bind9 https://hub.docker.com/r/ubuntu/bind9 with the following configuration : -For the named.conf

```
;Ma d claration de zone : trisomie21.org
$ORIGIN trisomie21.org.
$TTL 1d
```

-For the trisomie21.org.conf file

```
@ IN SOA serve.trisomie21.org. postmaster.trisomie21.org. (
2023081201 ;Serial
3h ;Refresh
1h ;Retry
1000h ;Expire
1d ;Negative Cache TTL
)
; Les serveurs de nom
@ IN NS server-dhcp-dns.domaine1.fr.
;Les adressages IP
@ IN A 192.168.10.2
server IN A 192.168.10.2
```

And adapt the DHCP to name the dynamic IP

SAMBA

We worked on the samba services but couldn't make it operational in time for testing it, anyway the docker should be usable soon.

commands

- Pull the docker image : docker pull dperson/samba
- Create the configuration folders :
- Launch the docker

Security

The security parts of the projects as only been theorized, we were unable to test it because we fully focused on the infrastructure and the services. The security part include ACL rules on the routers 0 and 2, allowing only the infrastructure network. A vpn is also implemented between the main site and the site 2, to secure connection through the internet.

ACL

As said before, the acl rules will be applied on the routers 0 and 2, to ensure that only the infrastructure network will be accepted. The acl rules are the following :

```
en
configure terminal
access-list 100 permit ip 192.168.11.0 0.0.0.255 any
access-list 100 permit ip 192.168.12.0 0.0.0.255 any
access-list 100 permit ip 192.168.13.0 0.0.0.255 any
access-list 100 permit ip 192.168.22.0 0.0.0.255 any
access-list 100 permit ip 192.168.23.0 0.0.0.255 any
access-list 100 permit ip 192.168.32.0 0.0.0.255 any
access-list 100 permit ip 192.168.33.0 0.0.0.255 any
access-list 100 permit ip 10.0.0.0 0.0.0.255 any
access-list 100 permit ip 10.1.0.0 0.0.0.255 any
access-list 100 permit ip 10.2.0.0 0.0.0.255 any
access-list 100 permit ip 10.3.0.0 0.0.0.255 any
access-list 100 permit ip 10.4.0.0 0.0.0.255 any
access-list 100 permit ip 10.5.0.0 0.0.0.255 any
access-list 100 permit ip 10.6.0.0 0.0.0.255 any
access-list 100 permit ip 10.7.0.0 0.0.0.255 any
access-list 100 permit ip 10.8.0.0 0.0.0.255 any
interface GigabitEthernet0/1
ip access-group 100 out
```

VPN

To securize the connection between the main site and the second site, we plannify to use a vpn, ipsec.

Difficulty encountered

We encountered multiple difficulty during this phase, the first one was the technical issue of the routers, forcing us to change the topology and the configurations multiple time.

It wasted a lot of time and create some confusion that lead us to rewrite the scripts multiple time. We also faced some diffilcuty in the configuration of the insite vlan, which was affecting the DHCP and if took us a lot of time to realize the issue and correct it.

Our last difficulty was to make sure our services were working since we were not able to test them in good condition frequently.

Conclusion

Although the initial phase of our project commenced with the design of the topology and the exploration of services, enabling us to gain a clearer vision of our objectives and organize our tasks more efficiently, we encountered various challenges along the way. Despite this, we ultimately achieved the majority of our goals. Initial technical issues related to routers necessitated adjustments in topology, IP addressing, and configuration, leading to delays and script revisions.

Notwithstanding these obstacles, our team successfully reached most of the set objectives. We managed to establish a comprehensive network infrastructure, encompassing not only routers but also switches, VLANs, as well as OSPF and BGP protocols to optimally address the specific needs of our organization. The successful implementation of DHCP protocol and a web server significantly enhanced the overall functionality of the network.

In conclusion, this project has been a learning experience, shedding light on the significant difference between theoretical simulation and practical reality. It has also demonstrated our ability to overcome unforeseen challenges and orchestrate the creation of an operational network infrastructure for Trisomy 21. This experience allowed us to develop our technical skills and collaborative aptitude within a team to achieve tangible goals.