Network Infrastructure Implementation Report

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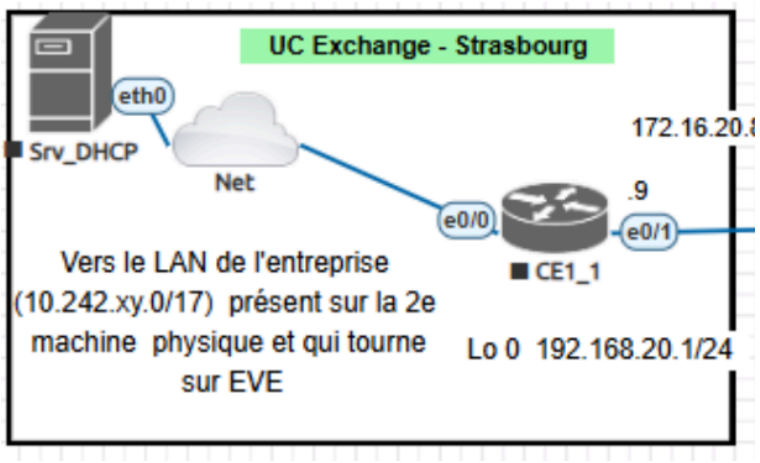
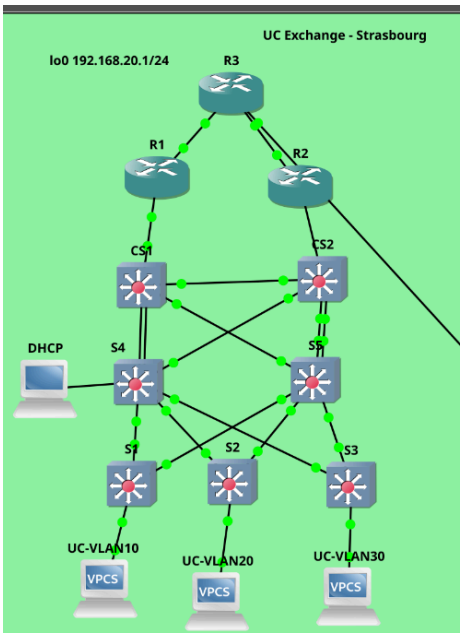


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We needed to address the concept of NAT and LAN. Initially, we configured the LAN (Net) according to the given addressing plan.

- **UC_Exchange**: 10.242.xy/17; UC_Exchange has two sites A0 and A1
- **ABC_Conseil**: 10.252.xy/18; ABC_Conseil has three sites B0, B1, B2



Addressing Plan Note

At the end of the project, I realized that I had inverted the X and Y in my addressing plan. However, I kept the same addressing plan for the validation.

1. Introduction/Context

As part of implementing a hierarchical network infrastructure for **UC Exchange** and **ABC Conseil**, we adopted a 3-tier architecture based on networking best practices. This design meets requirements for segmentation, redundancy, and scalability. The project involves the configuration of VLANs, inter-VLAN routing, and high availability.

2. Architecture Description

2.1 Access Layer

- **Composition:**
  - Three Layer 2 switches (S1/S2/S3)
  - Endpoints are directly connected to the access switches
  - 3 VPCS simulating client presence on the network
- **Role:**
  - Provides connectivity to endpoints
  - Manages VLAN trunking to the distribution switches
  - Ensures separation of services into VLANs

2.2 Distribution Layer

- **Composition:**
  - Two Layer 2/3 switches (S4/S5) responsible for inter-VLAN routing and connecting to the core network layer
- **Role:**
  - Ensures service separation into VLANs
  - Provides a physical and virtual gateway for endpoints
- **Specifics:**
  - A VTP server is configured on S5 to avoid creating VLANs on each switch.

2.3 Core Layer

- **Composition:**
  - Two core switches (**CS1, CS2**) connected via **EtherChannel** with routed (Layer 3) interfaces from S4 and S5.
  - The core switches handle OSPF routing between sites and maintain a stable and redundant interconnection.
- **Role:**
  - Ensures redundancy and high availability of communication between the access and distribution layers.
  - Provides connectivity to routers for external connections.

3. VLAN Configuration and Addressing Plan

We configured VLANs on the S5 switch, which is set up as a VTP server. We enabled pruning mode, used VTP version 3, and the VTP domain is set to **LAN**.

4. Key Configurations

4.1 VLAN Creation

```
S5(config)# vlan X
S5(config-vlan)# name <Department/IT_Service...>
S5(config)# do sh vl

S5#sh vl

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Gi0/0, Gi0/1, Gi0/2, Gi1/2
                                                 Gi1/3, Gi2/1, Gi2/2, Gi2/3
                                                 Gi3/2, Gi3/3
10   ServiceInformatique               active
20   Direction                         active
30   ServiceFinancier                  active
```

```
40   SalleServeur                       active
```

4.2 VTP Protocol

```
S5(config)# vtp mode server
S5(config)# vtp domain LAN
S5(config)# vtp version 3
S5(config)# vtp pruning
S5# show vtp status

VTP Version capable             : 1 to 3
VTP version running             : 3
VTP Domain Name                 : LAN
VTP Pruning Mode                : Enabled
VTP Traps Generation            : Disabled
Device ID                       : 0cd3.0d8d.8000

Feature VLAN:
--------------
VTP Operating Mode                : Server
Number of existing VLANs          : 9
Number of existing extended VLANs : 0
Maximum VLANs supported locally   : 4096
Configuration Revision            : 0
Primary ID                        : 0000.0000.0000
Primary Description               :
MD5 digest                        :
```

Other switches are configured in VTP client mode.

4.3 MSTP (Multiple Spanning Tree Protocol)

MSTP was used to prevent network loops and distribute traffic load across instances. This helps minimize convergence delay in case of failure.

We created two instances for VLANs:

- **Instance 1:** VLANs 10, 20
- **Instance 2:** VLANs 30, 40

On all switches:

```
spanning-tree mode mst
spanning-tree mst configuration
 name MSTLAN
 revision 1
 instance 1 vlan 10, 20
 instance 2 vlan 30, 40
```

On S5, you can verify the MST configuration:

```
S5#show spanning-tree mst configuration
Name      [MSTLAN]
Revision  1     Instances configured 3

Instance  Vlans mapped
--------  ---------------------------------------------------------------------
0         1-9,11-19,21-29,31-39,41-4094
1         10,20
2         30,40
---------------------------------------------------------------------------
```

4.4 Inter-VLAN Routing

Switches S4 and S5 host inter-VLAN routing interfaces with IP addresses acting as gateways for each VLAN.

On S5:

```
interface Vlan10
 ip address 10.242.10.200 255.255.255.0

interface Vlan20
 ip address 10.242.20.200 255.255.255.0

interface Vlan30
 ip address 10.242.30.200 255.255.255.0

interface Vlan40
 ip address 10.242.40.200 255.255.255.0
```

On S4:

```
interface Vlan10
 ip address 10.242.10.100 255.255.255.0

interface Vlan20
 ip address 10.242.20.100 255.255.255.0

interface Vlan30
 ip address 10.242.30.100 255.255.255.0

interface Vlan40
 ip address 10.242.40.100 255.255.255.0
```

Ping from UC-VLAN10 (VLAN10) 10.242.10.3/24 to UC-VLAN20 (VLAN20) 10.242.20.3/24:

```
UC-VLAN10> ping 10.242.20.3

84 bytes from 10.242.20.3 icmp_seq=1 ttl=63 time=41.189 ms
84 bytes from 10.242.20.3 icmp_seq=2 ttl=63 time=12.660 ms
84 bytes from 10.242.20.3 icmp_seq=3 ttl=63 time=10.462 ms
84 bytes from 10.242.20.3 icmp_seq=4 ttl=63 time=11.471 ms
84 bytes from 10.242.20.3 icmp_seq=5 ttl=63 time=25.526 ms
```

4.5 VRRP for High Availability

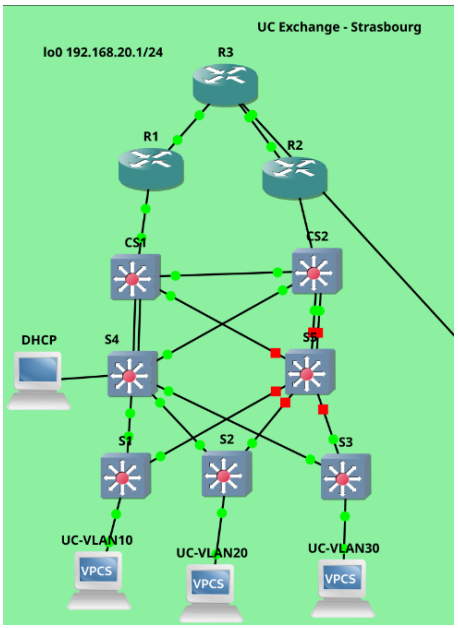
The VRRP protocol ensures high availability by providing virtual gateways to hosts. The protocol assigns a virtual gateway to each VLAN (see the addressing table).

The protocol is implemented on S4 and S5. Example of configuration (S4):

```
interface Vlan10
 ip address 10.242.10.100 255.255.255.0
 vrrp 10 ip 10.242.10.1
 vrrp 10 priority 105
!
interface Vlan20
 ip address 10.242.20.100 255.255.255.0
 vrrp 20 ip 10.242.20.1
 vrrp 20 priority 105
!
interface Vlan30
 ip address 10.242.30.100 255.255.255.0
 vrrp 30 ip 10.242.30.1
 vrrp 30 priority 95
!
interface Vlan40
 ip address 10.242.40.100 255.255.255.0
 vrrp 40 ip 10.242.40.1
 vrrp 40 priority 95
!
```

We change only priority on S5 for VLAN10,20.

Ping from PC1 with Virtual Gateway from S4 and S5 down




```
UC-VLAN10> ping 10.242.10.1

84 bytes from 10.242.10.1 icmp_seq=1 ttl=255 time=9.998 ms
84 bytes from 10.242.10.1 icmp_seq=2 ttl=255 time=4.172 ms
84 bytes from 10.242.10.1 icmp_seq=3 ttl=255 time=5.057 ms
84 bytes from 10.242.10.1 icmp_seq=4 ttl=255 time=7.537 ms
84 bytes from 10.242.10.1 icmp_seq=5 ttl=255 time=5.884 ms
```

Ping from PC1 with Virtual Gateway from S5 and S4 down

```
UC-VLAN10> ping 10.242.10.1

10.242.10.1 icmp_seq=1 timeout
84 bytes from 10.242.10.1 icmp_seq=2 ttl=255 time=141.627 ms
84 bytes from 10.242.10.1 icmp_seq=3 ttl=255 time=19.734 ms
84 bytes from 10.242.10.1 icmp_seq=4 ttl=255 time=66.553 ms
84 bytes from 10.242.10.1 icmp_seq=5 ttl=255 time=54.143 ms
```

4.6 EtherChannel

EtherChannel doubles the available bandwidth by aggregating two physical links into one virtual link. This protocol is used in the core network.

We created two port channels: one on S4 and another on S5.

On CS1:

```
interface Port-channel1
 no switchport
 ip address 10.10.10.6 255.255.255.252
```

On CS2:

```
interface Port-channel2
 no switchport
 ip address 10.10.10.2 255.255.255.252
```

On S4:

```
interface Port-channel1
 no switchport
 ip address 10.10.10.5 255.255.255.252
```

On S5:

```
interface Port-channel2
 no switchport
 ip address 10.10.10.1 255.255.255.252
```

On physical interfaces:

```
interface GigabitEthernet3/0
 description EtherChannel link
 no switchport
 channel-group 1 mode active
!
interface GigabitEthernet3/1
 description EtherChannel link
 no switchport
 channel-group 1 mode active
!
```

Proof of configuration

```
CS2#show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      N - not in use, no aggregation
        f - failed to allocate aggregator

        M - not in use, minimum links not met
        m - not in use, port not aggregated due to minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

        A - formed by Auto LAG


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
2      Po2(RU)         LACP      Gi3/0(P)    Gi3/1(P)
```

4.7 OSPF Routing

OSPF was chosen for routing between interconnected networks. Example OSPF configuration on R1:

```
router ospf 1
 network 10.10.10.20 0.0.0.3 area 0
 network 10.10.10.32 0.0.0.3 area 0
 default-information originate always
```

Routage table of R3 :

```
Gateway of last resort is 172.16.20.10 to network 0.0.0.0

      10.0.0.0/8 is variably subnetted, 15 subnets, 3 masks
O        10.10.10.0/30 [110/3] via 10.10.10.29, 00:03:15, FastEthernet0/0
O        10.10.10.4/30 [110/3] via 10.10.10.33, 00:00:19, FastEthernet1/0
O        10.10.10.8/30 [110/3] via 10.10.10.33, 00:47:11, FastEthernet1/0
                       [110/3] via 10.10.10.29, 00:47:47, FastEthernet0/0
O        10.10.10.12/30 [110/3] via 10.10.10.33, 00:05:42, FastEthernet1/0
O        10.10.10.16/30 [110/3] via 10.10.10.29, 00:03:59, FastEthernet0/0
O        10.10.10.20/30 [110/2] via 10.10.10.33, 00:47:11, FastEthernet1/0
O        10.10.10.24/30 [110/2] via 10.10.10.29, 00:47:47, FastEthernet0/0
O        10.242.10.0/24 [110/4] via 10.10.10.33, 00:03:49, FastEthernet1/0
                        [110/4] via 10.10.10.29, 00:03:15, FastEthernet0/0
O        10.242.20.0/24 [110/4] via 10.10.10.33, 00:03:49, FastEthernet1/0
                        [110/4] via 10.10.10.29, 00:03:15, FastEthernet0/0
O        10.242.30.0/24 [110/4] via 10.10.10.33, 00:03:49, FastEthernet1/0
                        [110/4] via 10.10.10.29, 00:03:15, FastEthernet0/0
O        10.242.40.0/24 [110/4] via 10.10.10.33, 00:03:49, FastEthernet1/0
                        [110/4] via 10.10.10.29, 00:03:15, FastEthernet0/0
R3#
```

5. DHCP Configuration

We used DHCP to give dynamic address IP on VLANs.

Screen from our configuration on S4

```
S4#sh run | include helper
 ip helper-address 10.242.40.102
 ip helper-address 10.242.40.102
 ip helper-address 10.242.40.102
 ip helper-address 10.242.40.102
S4#
```

We add ip helper-address on all VLANs interface

Its the same configuration on S5

DORA DHCP Screen (local server)

```
UC-VLAN10> ip dhcp
DORA IP 10.242.10.6/24 GW 10.242.10.1
```

We can see clients can have IP from the DHCP Server.

6. NAT Configuration for External Connectivity

We used PAT for NAT, defining inside and outside interfaces. Example:

```
interface FastEthernet0/0
 ip address 10.10.10.30 255.255.255.252
 ip nat inside
 duplex full
!
interface FastEthernet1/0
 ip address 10.10.10.34 255.255.255.252
 ip nat inside
 speed auto
 duplex auto
!
interface FastEthernet1/1
 ip address 172.16.20.9 255.255.255.252
 ip nat outside
 speed auto
 duplex auto
!
```

A NAT ACL was created to allow address translation for VLAN networks:

```
access-list 1 permit 10.242.10.0 0.0.0.255
access-list 1 permit 10.242.20.0 0.0.0.255
access-list 1 permit 10.242.30.0 0.0.0.255
access-list 1 permit 10.242.40.0 0.0.0.255
access-list 1 permit 10.10.0.0 0.0.255.255
access-list 1 permit 10.242.0.0 0.0.255.255
ip nat inside source list 1 interface FastEthernet1/1 overload
```

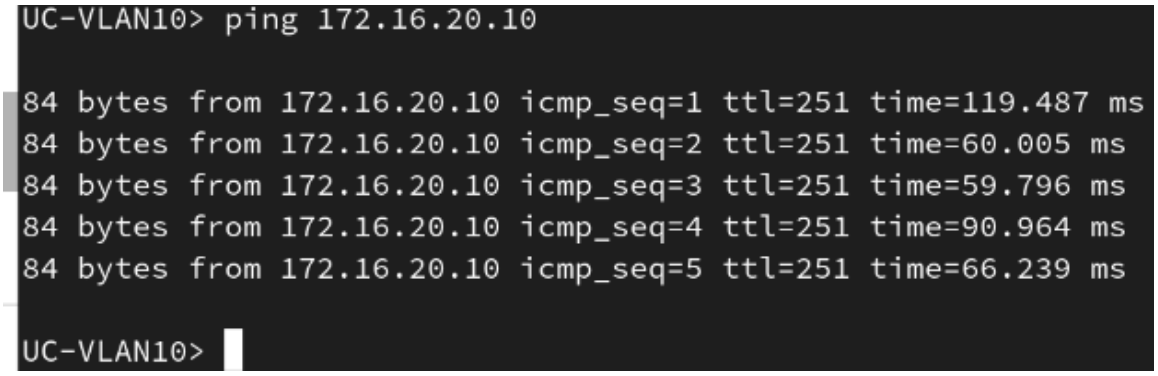
This concludes the detailed implementation report for **UC Exchange** and **ABC Conseil**.

To test the nat firstly activate the debug

```
R3# debug ip nat
IP NAT debugging is on
```

We ping interface on FAI 172.16.20.10 (PE1) from UC-VLAN10 to PE1 and show on R3 the debug

```
R3#show ip nat translations
Pro Inside global      Inside local       Outside local      Outside global
icmp 172.16.20.9:16808 10.242.10.6:16808  172.16.20.10:16808 172.16.20.10:16808
icmp 172.16.20.9:17064 10.242.10.6:17064  172.16.20.10:17064 172.16.20.10:17064
icmp 172.16.20.9:17576 10.242.10.6:17576  172.16.20.10:17576 172.16.20.10:17576
icmp 172.16.20.9:17832 10.242.10.6:17832  172.16.20.10:17832 172.16.20.10:17832
icmp 172.16.20.9:18088 10.242.10.6:18088  172.16.20.10:18088 172.16.20.10:18088
tcp 172.16.20.9:49587  10.242.40.102:49587 10.242.41.103:53  10.242.41.103:53
udp 172.16.20.9:58776  10.242.40.102:58776 10.242.41.102:53  10.242.41.102:53
udp 172.16.20.9:58776  10.242.40.102:58776 10.242.41.103:53  10.242.41.103:53
udp 172.16.20.9:63786  10.242.40.102:63786 10.242.41.102:53  10.242.41.102:53
udp 172.16.20.9:63786  10.242.40.102:63786 10.242.41.103:53  10.242.41.103:53
udp 172.16.20.9:63788  10.242.40.102:63788 10.242.41.102:53  10.242.41.102:53
udp 172.16.20.9:63788  10.242.40.102:63788 10.242.41.103:53  10.242.41.103:53
R3#
```



Static Routing Configuration

```
ip route 0.0.0.0 0.0.0.0 172.16.20.10
ip route 192.168.40.0 255.255.255.0 172.16.20.10
```

The first route allows the router to reach the internet through the ISP's gateway.

The second route allows the router to reach the loopback interface of the router CE1-2 router on FAI.

Network Configuration Tables

- Locations:
  - **A0**: UC_Exchanges Strasbourg
  - **A1**: UC_Exchanges Metz
  - **B0**: ABC_Conseil Strasbourg
  - **B1**: ABC_Conseil Nancy
  - **B2**: ABC_Conseil Metz

IP configuration used on project (I reversed X and Y)

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
Site UC_exchange Strasbourg **A0**	**10.242.yx.0/17**		
1 Natif	10.242.0.0/24	-	-
10 ServiceInformatique	10.242.**1**0.0/24	10.242.10.1	10.242.10.1/2/100/200/254/102
20 Direction	10.242.**2**0.0/24	10.242.20.1	10.242.20.1/2/100/200/254/102
30 ServiceFinancier	10.242.**3**0.0/24	10.242.30.1	10.242.30.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
40 SalleServeur	10.242.**4**0.0/24	10.242.40.1	10.242.40.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
Site UC_exchange Metz **A1**	**10.242.yx.0/18**		
1 Natif	10.242.1.0/24	-	-
10 ServiceInformatique	10.242.**1**1.0/24	10.242.11.1	10.242.11.1/2/100/200/254/102
20 Direction	10.242.**2**1.0/24	10.242.21.1	10.242.21.1/2/100/200/254/102
30 ServiceFinancier	10.242.**3**1.0/24	10.242.31.1	10.242.31.1/2/100/200/254/102
40 SalleServeur	10.242.**4**1.0/24	10.242.41.1	10.242.41.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
Site ABC_Conseil Strasbourg **B0**	**10.252.yx.0/18**		
1 Natif	10.252.1.0/24	-	-
10 ServiceInformatique	10.252.**1**0.0/24	10.242.11.1	10.242.11.1/2/100/200/254/102
20 Direction	10.252.**2**0.0/24	10.242.21.1	10.242.21.1/2/100/200/254/102
30 ServiceFinancier	10.252.**3**0.0/24	10.242.31.1	10.242.31.1/2/100/200/254/102
40 SalleServeur	10.252.**4**0.0/24	10.242.41.1	10.242.41.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
Site ABC_Conseil Nancy **B1**	**10.252.yx.0/18**		
1 Natif	10.252.1.0/24	-	-
10 ServiceInformatique	10.252.**1**1.0/24	10.242.11.1	10.242.11.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
20 Direction	10.252.**2**1.0/24	10.242.21.1	10.242.21.1/2/100/200/254/102
30 ServiceFinancier	10.252.**3**1.0/24	10.242.31.1	10.242.31.1/2/100/200/254/102
40 SalleServeur	10.252.**4**1.0/24	10.242.41.1	10.242.41.1/2/100/200/254/102

Nom VLAN	IP_NET/MASK	Gateway	Adresse_DHCP_Exclu
Site ABC_Conseil Metz **B2**	**10.252.yx.0/18**		
1 Natif	10.252.1.0/24	-	-
10 ServiceInformatique	10.252.**1**2.0/24	10.242.11.1	10.242.11.1/2/100/200/254/102
20 Direction	10.252.**2**2.0/24	10.242.21.1	10.242.21.1/2/100/200/254/102
30 ServiceFinancier	10.252.**3**2.0/24	10.242.31.1	10.242.31.1/2/100/200/254/102
40 SalleServeur	10.252.**4**2.0/24	10.242.41.1	10.242.41.1/2/100/200/254/102