Université Libre de Bruxelles

ECOLE
POLYTECHNIQUE
DE BRUXELLES

Communication networks : protocols and architectures
ELEC-H417

Lab 3 - VLAN

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December 2023

Academic year 2023-2024

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1 Introduction

The objective of this laboratory is to understand how does L2 isolation via dot1q (or VLAN - Virtual Local Area Network) works, implement them and communicate between VLANs using EtherSwitches and Routers.

2 Topology

The topology has been reproduced in the GNS3 window, the router, EtherSwitches and VPCs were correctly setup.

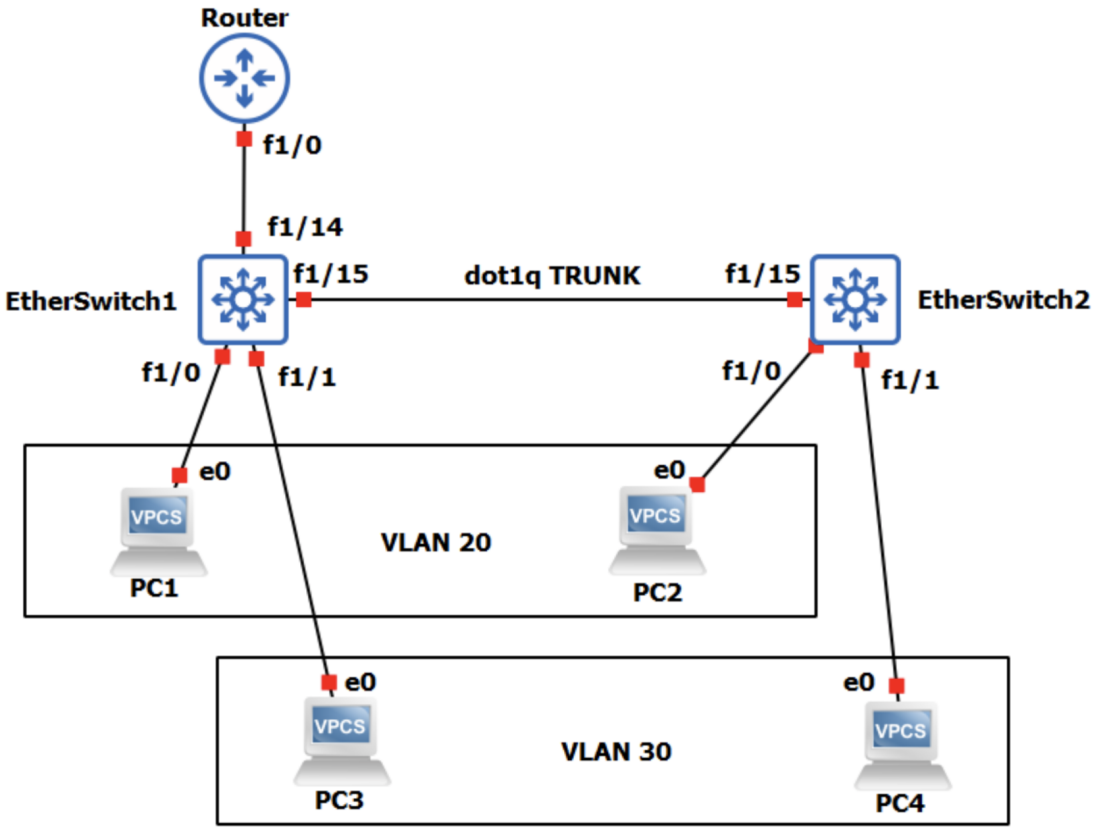

Figure 1: Topology of the Lab

3 Mission 1: VLAN isolation and trunking

In this mission, the objective is to set up two VLANs and see how it affects the communication between VPCs.

3.1 Step 1

```
PC1> ip 192.168.20.2/16 192.168.20.1
Checking for duplicate address...
PC1 : 192.168.20.2 255.255.0.0 gateway 192.168.20.1

PC1> ping 192.168.30.2

84 bytes from 192.168.30.2 icmp_seq=1 ttl=64 time=0.437 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=64 time=1.767 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=64 time=2.594 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=64 time=1.663 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=64 time=0.701 ms
```

Figure 2: Netmask adjusting and ping from PC1 to PC3

Initially, the two PCs can not communicate because they are on different subnets (the netmask being 255.255.255.0). By adjusting the netmask of PC1 and PC3 to /16 (255.255.0.0), the 2 PCs are on the same subnet (192.168) and thus PC1 can ping PC3.

3.2 Step 2 - Configuration of the VLANs

3.2.1 Configuration of the EtherSwitches

```
EtherSwitch1#show vlan-switch

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa1/2, Fa1/3, Fa1/4, Fa1/5
                                                Fa1/6, Fa1/7, Fa1/8, Fa1/9
                                                Fa1/10, Fa1/11, Fa1/12, Fa1/13
                                                Fa1/14, Fa1/15
20   VLAN0020                         active    Fa1/0
30   VLAN0030                         active    Fa1/1
1002 fddi-default                     active
1003 token-ring-default               active
1004 fddinet-default                  active
1005 trnet-default                    active

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        1002   1003
20   enet  100020     1500  -      -      -        -    -        0      0
30   enet  100030     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        1      1003
1003 tr    101003     1500  1005   0      -        -    srb      1      1002
1004 fdnet 101004     1500  -      -      1        ibm  -        0      0
1005 trnet 101005     1500  -      -      1        ibm  -        0      0
EtherSwitch1#
```

Figure 3: Configuration of EtherSwitch 1

The EtherSwitch1 is well-connected to VLAN 20 and VLAN 30 through ports f1/0 and f1/1.

It can also be seen that the VLANs 20 and 30 are present in the database, but there is also the VLAN 1 that is set up by default, it is the management VLAN and will not be used directly by the user in this lab.

The EtherSwitch 2 has the been configured similarly.

3.2.2 Pinging from PC1 to PC3

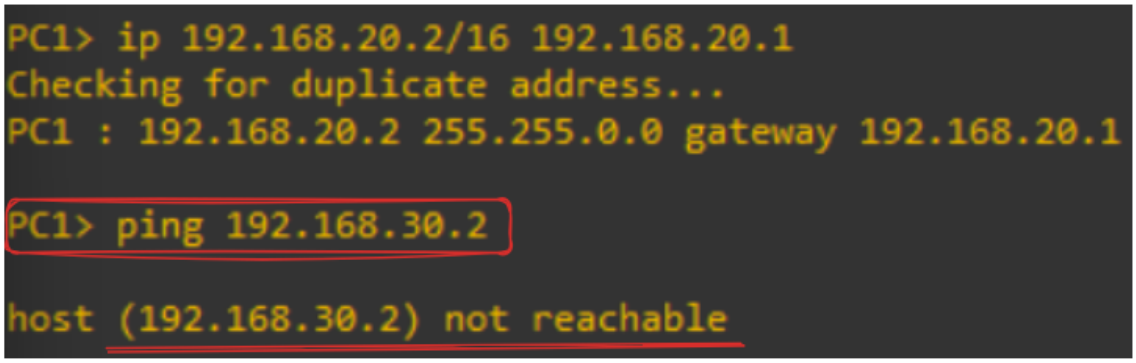

Figure 4: Ping from PC1 to PC3

Now that the EtherSwitches are configured for VLANs 20 and 30, it is not possible anymore to ping from PC1 (that is in VLAN 20 –192.168.20.2) to PC3 (that is in VLAN 30 – 192.168.30.2). This is expected because the EtherSwitches are partitioned in two logical separations (one for each VLAN). It is not possible to go from a VLAN to another without passing through a router (see section 5).

Similarly, between PC2 and PC4, the same result is observed. Successful pinging occurred when the netmask was set to 255.255.0.0, and the EtherSwitches were not configured for VLANs. However, when the EtherSwitches are configured for the two VLANs, the ping functionality is disrupted.

4 Mission 2: Trunking

Note: The netmask of all the PCs have been reconfigured in 24 bytes.

The objective of this mission is to understand what a trunk is and implement it between the two EtherSwitches.

Port `f1/15` of EtherSwitch1 has been configured in `trunk` mode, allowing it to transmit messages from all VLANs. Subsequently, these messages are forwarded to EtherSwitch2. It's important to note that EtherSwitch2 has the capability to transmit messages exclusively within the same VLAN as the source. The Etherswitch2 has also been configured the same way to allow bidirectional communication.

Trunking involves carrying traffic for multiple VLANs over a single network link. Here, all VLANs can use this link. But it is possible, and even preferable for larger systems, to use a trunk link selectively for specific VLANs.

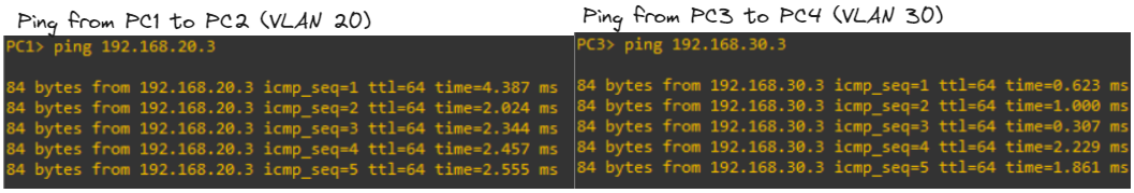

Figure 5: Ping from PC1 to PC2 and from PC3 to PC4

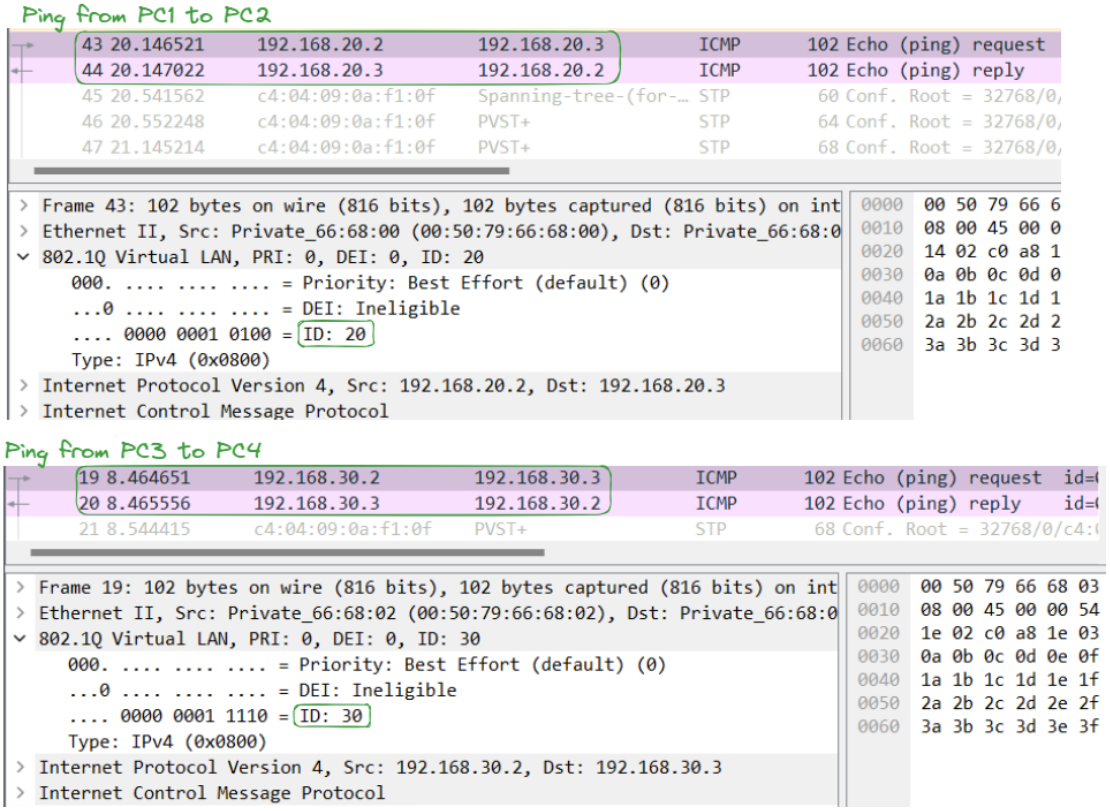

Figure 6: WireShark capture between EtherSwitches 1 and 2

When pinging within VLAN 20 from PC1 to PC2, it can be observed in Figure 6 that the VLAN ID is 20. As a result, it can only be transmitted to and from a device configured on a VLAN 20 interface.
Similarly, for the pinging from PC3 to PC4, it can be seen that the VLAN ID is 30.

This proves that the trunk between the two EtherSwitches is working effectively.

5 Mission 3: Inter-VLAN routing

The objective of this mission is to communicate between the two VLANs. For example, send a ping from PC1 to PC3 (from VLAN 20 to VLAN 30). This will

be done by configuring a **router on a stick**, a single router interface used to interconnect multiple virtual LANs (VLANs.

5.1 Implementation of the router

First, the `f1/14` port of the EtherSwitch needs to be in `trunk` mode for all VLANs (or at least VLANs 20 and 30).

Then, the router needs to activate the VLANs and give an IP address to each VLAN interface on the router (because a router is a Layer 3 equipment).

Once everything is configured, a ping can be sent from PC1 (or another PC) to everywhere and will pass through the router if it needs to change VLANs.

5.2 Step 1: Ping Router from PC1

```
PC1> ping 192.168.20.1

84 bytes from 192.168.20.1 icmp_seq=1 ttl=255 time=10.499 ms
84 bytes from 192.168.20.1 icmp_seq=2 ttl=255 time=11.270 ms
84 bytes from 192.168.20.1 icmp_seq=3 ttl=255 time=10.461 ms
84 bytes from 192.168.20.1 icmp_seq=4 ttl=255 time=9.886 ms
84 bytes from 192.168.20.1 icmp_seq=5 ttl=255 time=1.572 ms
```

Figure 7: Ping from PC1 to Router 1

This ping shows that the setup is working and PC1 can communicate with the router.

5.3 Step 2: Ping between PC1 and PC3

Now that the router is connected and correctly set up, let's try to ping from PC1 to PC3.

```
PC1> ping 192.168.30.2

84 bytes from 192.168.30.2 icmp_seq=1 ttl=63 time=21.805 ms
84 bytes from 192.168.30.2 icmp_seq=2 ttl=63 time=17.771 ms
84 bytes from 192.168.30.2 icmp_seq=3 ttl=63 time=22.905 ms
84 bytes from 192.168.30.2 icmp_seq=4 ttl=63 time=13.344 ms
84 bytes from 192.168.30.2 icmp_seq=5 ttl=63 time=22.952 ms
```

Figure 8: Ping from PC1 to PC3

The ping is successful. It shows that the implementation of the router allows communication between different VLANs. The path followed is:

1. PC 1 (VLAN 20)
2. EtherSwitch 1 (VLAN 20)
3. Router (VLAN 20) - Router (VLAN 30)
4. EtherSwitch 1 (VLAN 30)
5. PC 3 (VLAN 30)

5.4 Step 3: Monitoring the stick line

A **router on a stick** is a router with only one link to the switches and VLANs. In this case, the "stick" line is the link between the Router and EtherSwitch1.

Now that a router is connected and set up correctly, let's ping from PC1 to PC3 again to see what happens.

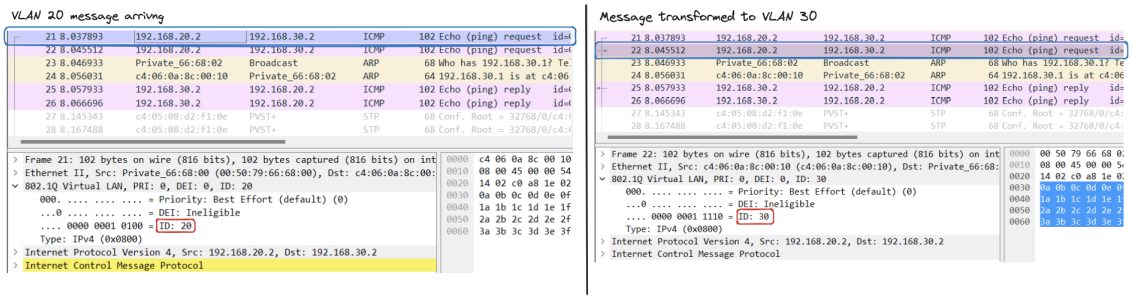

Figure 9: Wireshark capture for a ping between PC 1 and PC 3

This figure 9 shows that the router manages the transition from VLAN 20 to VLAN 30. This is seen by looking at the ID values inside the body of the message (first 20 then 30).

6 Conclusion

In conclusion, the implementation of trunking and VLANs in this laboratory has showcased their powerful capabilities in network management. VLANs provide an effective means of logically segmenting a network, improving security, and optimizing traffic flow. Trunking, by allowing the transmission of multiple VLANs over a single link, enhances network efficiency.

Trunking, on the other hand, streamlines network infrastructure but demands careful configuration and consideration of bandwidth usage to avoid security issues such as VLAN hopping.

The implementation of a router on a stick further enabled inter-VLAN communication, showcasing the importance of routers in such scenarios. But on the other hand, every communication has to go through the stick line, which makes it prone to congestion. Which could lead to packet losses or delays.

Switches are usually used at the edge of a network to organise communication in a local network. Here are some pros and cons of switches instead of routers :

Pros	**Cons**
• Less expensive than routers • Simpler to configure • Faster than routers (doesn't have to compute routing information)	• Can't connect to elements in different subnets • Usually less functionalities than routers • Less security