Faculté des Sciences & Techniques — Université de Limoges

Master 1ère année

Admin Rés

TP n°1.5

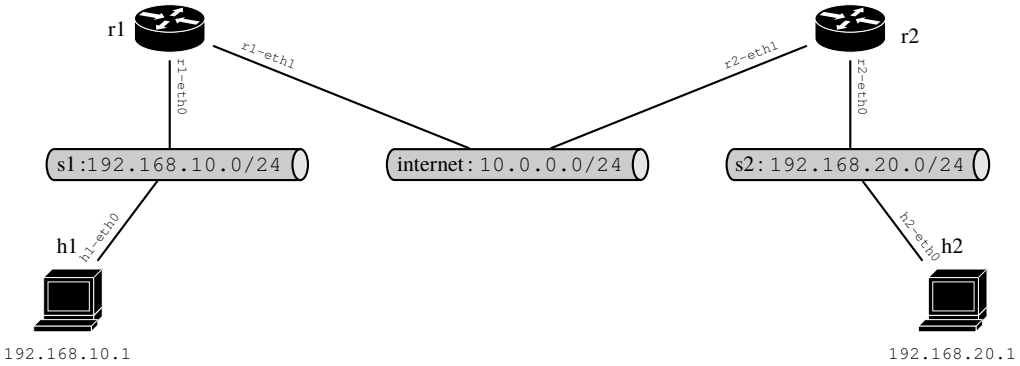
Configuration réseau, « sniffing » & virtualisation & VLANs

Plateforme virtuelle et VLANs

On va reprendre le réseau du TP nº1, où au lieu de 3 swicthes, on va n'en utiliser qu'un seul :

- 3 réseaux correspondant sur un seul switch ;
- deux routeurs `r1` et `r2` ;
- deux hôtes, `h1` et `h2`, chacun connecté dans le réseau `s` respectif.

switch/réseau	adresse
s1	192.168.10.0/24
s2	192.168.20.0/24
internet	10.0.0.0/24



Utilisation d'un seul switch pour tout connecter

On modifie le fichier« `build_architecture` » :

```
# créer le switch
# ovs-vsctl add-br internet
# ovs-vsctl add-br s1
# ovs-vsctl add-br s2
ovs-vsctl add-br switch
```

On remplace les 3 switches par un seul appelé « `swicth` ».
Puis on modifie les connexions :

```
ovs-vsctl add-port switch s1-h1
ovs-vsctl add-port switch s1-h3
ovs-vsctl add-port switch s1-r1
ovs-vsctl add-port switch s2-h2
ovs-vsctl add-port switch s2-r2

ovs-vsctl add-port switch internet-r1
ovs-vsctl add-port switch internet-r2
```

On « *ping* » `h2` depuis `h1` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
64 bytes from 192.168.20.1: icmp_seq=1 ttl=62 time=3.05 ms

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 3.046/3.046/3.046/0.000 ms
```

Ça marche !
Mais comment ? On passe par `r1` !

```
xterm
pef@palomino:~$ [h1] sudo tcpdump -lnvveX -i h1-eth0 not ip6
tcpdump: listening on h1-eth0, link-type EN10MB (Ethernet), snapshot length 262144
bytes
23:28:59.015816 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.10.254 tell
192.168.10.1, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  0a01 0000 0000 0000 c0a8 0afe            ............
23:28:59.016617 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.10.254 is-at
66:f1:76:90:a9:21, length 28
        0x0000:  0001 0800 0604 0002 66f1 7690 a921 c0a8  ........f.v..!..
        0x0010:  0afe d2cc 44e8 3c6d c0a8 0a01            ....D.<m....
23:28:59.016632 d2:cc:44:e8:3c:6d > 66:f1:76:90:a9:21, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 25348, offset 0, flags [DF], proto ICMP (1), length
84)
    192.168.10.1 > 192.168.20.1: ICMP echo request, id 21920, seq 1, length 64
        0x0000:  4500 0054 6304 4000 4001 3852 c0a8 0a01  E..Tc.@.@.8R....
        0x0010:  c0a8 1401 0800 5280 55a0 0001 ab68 4965  ......R.U....hIe
        0x0020:  0000 0000 9c3d 0000 0000 0000 1011 1213  .....=..........
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:28:59.016704 f2:01:9e:99:31:ac > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.10.254 is-at
f2:01:9e:99:31:ac, length 28
        0x0000:  0001 0800 0604 0002 f201 9e99 31ac c0a8  ............1...
        0x0010:  0afe d2cc 44e8 3c6d c0a8 0a01            ....D.<m....
23:28:59.017087 f2:01:9e:99:31:ac > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 10.0.0.2 tell 10.0.0.1,
length 28
        0x0000:  0001 0800 0604 0001 f201 9e99 31ac 0a00  ............1...
        0x0010:  0001 0000 0000 0000 0a00 0002            ............
23:28:59.017743 b6:08:5d:75:74:a4 > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.20.1 tell
192.168.20.254, length 28
        0x0000:  0001 0800 0604 0001 b608 5d75 74a4 c0a8  ..........]ut...
        0x0010:  14fe 0000 0000 0000 c0a8 1401            ............
23:28:59.018818 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 62, id 51432, offset 0, flags [none], proto ICMP (1),
length 84)
    192.168.20.1 > 192.168.10.1: ICMP echo reply, id 21920, seq 1, length 64
        0x0000:  4500 0054 c8e8 0000 3e01 146e c0a8 1401  E..T....>..n....
        0x0010:  c0a8 0a01 0000 5a80 55a0 0001 ab68 4965  ......Z.U....hIe
        0x0020:  0000 0000 9c3d 0000 0000 0000 1011 1213  .....=..........
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:29:04.164547 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.10.1 tell
192.168.10.254, length 28
        0x0000:  0001 0800 0604 0001 66f1 7690 a921 c0a8  ........f.v..!..
        0x0010:  0afe 0000 0000 0000 c0a8 0a01            ............
23:29:04.164568 d2:cc:44:e8:3c:6d > 66:f1:76:90:a9:21, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.10.1 is-at
d2:cc:44:e8:3c:6d, length 28
        0x0000:  0001 0800 0604 0002 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  0a01 66f1 7690 a921 c0a8 0afe            ..f.v..!....
```

Ok ⟹ comme dans un réseau bien fait : on fait de l'ARP pour obtenir l'@MAC du routeur, puis on passe par lui pour envoyer le paquet « *ICMP request* » et c'est lui qui nous retourne le paquet « *ICMP reply* » !

Mais c'est quoi ces messages **ARP supplémentaires** ??

- ▷ un « *echo reply* » de la part de la seconde interface de `r1` ??
  C'est comme si `r1` avait reçu le broadcast de la requête ARP de `h1` qui le concerne sur ces deux interfaces
  ⟹ c'est vrai le broadcast est "floodé" sur tous les ports du switch.
- ▷ une requête ARP pour `10.0.0.2` => c'est `r1` qui cherche `r2`
- ▷ une requête ARP pour `192.168.20.1` => c'est `r2` qui cherche `h2`

Toutes les requêtes ARP transmises en brodcast sont reçus par `h1` !!!
⟹ pas d'isolation !!!

Un seul switch n'apporte aucune isolation de niveau 2⟹ il faut des VLANs !

Pour connaître les adresses MAC respectives et interpréter correctement la capture de `tcpdump` :

xterm

```
pef@palomino:~$ [r1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
80: r1-eth0@if79: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether 66:f1:76:90:a9:21 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.254/24 scope global r1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::64f1:76ff:fe90:a921/64 scope link
       valid_lft forever preferred_lft forever
82: r1-eth1@if81: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether f2:01:9e:99:31:ac brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 10.0.0.1/24 scope global r1-eth1
       valid_lft forever preferred_lft forever
    inet6 fe80::f001:9eff:fe99:31ac/64 scope link
       valid_lft forever preferred_lft forever
```

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
74: h1-eth0@if73: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
```

Mais, si sur `h1`, je me configure dans le réseau de `h2` ?

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 192.168.20.42/24 dev h1-eth0
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
74: h1-eth0@if73: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet 192.168.20.42/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
64 bytes from 192.168.20.1: icmp_seq=1 ttl=64 time=1.20 ms

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.200/1.200/1.200/0.000 ms
```

On regarde comment ça marche :

xterm

```
23:29:21.963787 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.20.1 tell
192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
23:29:21.964593 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.20.1 is-at
5e:6d:ee:ba:fc:7b, length 28
        0x0000:  0001 0800 0604 0002 5e6d eeba fc7b c0a8  ........^m...{..
        0x0010:  1401 d2cc 44e8 3c6d c0a8 142a            ....D.<m...*
23:29:21.964608 d2:cc:44:e8:3c:6d > 5e:6d:ee:ba:fc:7b, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 2476, offset 0, flags [DF], proto ICMP (1), length
84)
    192.168.20.42 > 192.168.20.1: ICMP echo request, id 52693, seq 1, length 64
        0x0000:  4500 0054 09ac 4000 4001 8781 c0a8 142a  E..T..@.@......*
        0x0010:  c0a8 1401 0800 c3d3 cdd5 0001 c168 4965  .............hIe
        0x0020:  0000 0000 8eb4 0e00 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:29:21.964926 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 18751, offset 0, flags [none], proto ICMP (1),
length 84)
    192.168.20.1 > 192.168.20.42: ICMP echo reply, id 52693, seq 1, length 64
        0x0000:  4500 0054 493f 0000 4001 87ee c0a8 1401  E..TI?..@.......
        0x0010:  c0a8 142a 0000 cbd3 cdd5 0001 c168 4965  ...*.........hIe
        0x0020:  0000 0000 8eb4 0e00 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
```

Pour connaître les adresses MAC respectives et interpréter correctement la capture de `tcpdump` :

xterm

```
pef@palomino:~$ [h2] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
76: h2-eth0@if75: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether 5e:6d:ee:ba:fc:7b brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.20.1/24 scope global h2-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::5c6d:eeff:feba:fc7b/64 scope link
       valid_lft forever preferred_lft forever
```

⟹ `h1` ne fait plus de routage !!!

⟹ On va directement de `h1` vers `h2` !!!

⟹ On a bien **aucune isolation !!!**

Première configuration de VLAN : un port ⟹ un VLAN

On modifie le fichier « `build_architecture` » :

```
ovs-vsctl add-port switch s1-h1 tag=100
ovs-vsctl add-port switch s1-h3 tag=100
ovs-vsctl add-port switch s1-r1 tag=100
ovs-vsctl add-port switch s2-h2 tag=200
ovs-vsctl add-port switch s2-r2 tag=200

ovs-vsctl add-port switch internet-r1 tag=300
ovs-vsctl add-port switch internet-r2 tag=300
```

- Le VLAN 100 correspond au réseau `192.168.10.0/24`
- Le VLAN 200 correspond au réseau `192.168.20.0/24`
- Le VLAN 300 correspond au réseau `10.0.0.0/24`

Est-ce que l'on a bien de l'isolation ? On va essayer de rejoindre le réseau `10.0.0.0/24` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
58: h1-eth0@if57: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 10.0.0.42/24 dev h1-eth0
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```

Ouf l'isolation est bonne !

Mais est-ce vraiment le cas ?

xterm

```
pef@palomino:~$ [h1] sudo tcpdump -lnvveX -i h1-eth0 not ip6
tcpdump: listening on h1-eth0, link-type EN10MB (Ethernet), snapshot length 262144
bytes
23:15:31.778517 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 10.0.0.1 tell 10.0.0.42,
length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d 0a00  ..........D.<m..
        0x0010:  002a 0000 0000 0000 0a00 0001            .*..........
23:15:31.779141 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 10.0.0.1 is-at 66:f1:76:90:a9:21,
length 28
        0x0000:  0001 0800 0604 0002 66f1 7690 a921 0a00  ........f.v..!..
        0x0010:  0001 d2cc 44e8 3c6d 0a00 002a            ....D.<m...*
23:15:31.779154 d2:cc:44:e8:3c:6d > 66:f1:76:90:a9:21, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 50459, offset 0, flags [DF], proto ICMP (1), length
84)
    10.0.0.42 > 10.0.0.1: ICMP echo request, id 62504, seq 1, length 64
        0x0000:  4500 0054 c51b 4000 4001 6163 0a00 002a  E..T..@.@.ac...*
        0x0010:  0a00 0001 0800 8357 f428 0001 8365 4965  .......W.(...eIe
        0x0020:  0000 0000 e9e0 0b00 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
```

Horreur !!! la requête ARP a été transmise vers `r1` et une réponse reçue par `h1` !!!

Regardons tout de même les adresses MACs utilisées :

xterm

```
pef@palomino:~$ [r1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
64: r1-eth0@if63: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether 66:f1:76:90:a9:21 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.254/24 scope global r1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::64f1:76ff:fe90:a921/64 scope link
       valid_lft forever preferred_lft forever
66: r1-eth1@if65: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether f2:01:9e:99:31:ac brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 10.0.0.1/24 scope global r1-eth1
       valid_lft forever preferred_lft forever
    inet6 fe80::f001:9eff:fe99:31ac/64 scope link
       valid_lft forever preferred_lft forever
```

Mais qu'elle est l'adresse MAC donnée en réponse ? Celle de l'interface de `r1` connectée au VLAN de h1, c-à-d `66:f1:76:90:a9:21`...

Est-ce normal ? Oui le routeur dispose de **deux adresses IPs**, chacune associée à une de ses deux interfaces réseaux, donc il répond **mais n'accepte pas un paquet provenant de la mauvaise interface** (celle qui n'est pas raccordée au réseau d'entrée du paquet de h1).
⟹ l'isolation est bonne, mais pourrait être meilleure mais `r1` est un routeur.

Et si on recommence, en essayant vers `h2` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
58: h1-eth0@if57: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet 10.0.0.42/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 192.168.20.42/24 dev h1-eth0
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
58: h1-eth0@if57: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet 192.168.20.42/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet 10.0.0.42/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
pef@palomino:~/NET_LAB_VLAN$ [h1] ip r
default via 192.168.10.254 dev h1-eth0
10.0.0.0/24 dev h1-eth0 proto kernel scope link src 10.0.0.42
192.168.10.0/24 dev h1-eth0 proto kernel scope link src 192.168.10.1
192.168.20.0/24 dev h1-eth0 proto kernel scope link src 192.168.20.42
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
From 192.168.20.42 icmp_seq=1 Destination Host Unreachable

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 0ms
```

Rien ne passe et si on observe le trafic :

xterm

```
23:20:56.718269 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.20.1 tell
192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
23:20:57.732774 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.20.1 tell
192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
23:20:58.756571 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.20.1 tell
192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
```

⟹pas de réponse ARP depuis h2 : l'isolation est bonne !!!

Essayons d'aller d'un VLAN à un autre en ajoutant une encapsulation VLAN sur `h1`, pour rejoindre `h2` :

xterm
```
sudo ip l add link h1-eth0 name vers_vlan200 type vlan id 200
sudo ip l set vers_vlan200 up
sudo ip a add 192.168.20.42/24 dev vers_vlan200
```

on supprimera avant, l'adresse `192.168.20.42` de l'interface h1-eth0.

On vérifie la configuration :

xterm
```
pef@palomino:~/NET_LAB_VLAN$ [h1] ip l
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode DEFAULT
group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: vers_vlan200@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP mode DEFAULT group default qlen 1000
    link/ether be:f3:b3:20:e0:96 brd ff:ff:ff:ff:ff:ff
10: h1-eth0@if9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
mode DEFAULT group default qlen 1000
    link/ether be:f3:b3:20:e0:96 brd ff:ff:ff:ff:ff:ff link-netnsid 0

pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: vers_vlan200@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP group default qlen 1000
    link/ether be:f3:b3:20:e0:96 brd ff:ff:ff:ff:ff:ff
    inet 192.168.20.42/24 scope global vers_vlan200
       valid_lft forever preferred_lft forever
    inet6 fe80::bcf3:b3ff:fe20:e096/64 scope link
       valid_lft forever preferred_lft forever
10: h1-eth0@if9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether be:f3:b3:20:e0:96 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::bcf3:b3ff:fe20:e096/64 scope link
       valid_lft forever preferred_lft forever

pef@palomino:~/NET_LAB_VLAN$ [h1] ip r
default via 192.168.10.254 dev h1-eth0
192.168.10.0/24 dev h1-eth0 proto kernel scope link src 192.168.10.1
192.168.20.0/24 dev vers_vlan200 proto kernel scope link src 192.168.20.42
```

Si on essaye de 'pinger' vers la machine `h2` :

xterm
```
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
From 192.168.20.42 icmp_seq=1 Destination Host Unreachable

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 0ms
```

⟹ **ca ne marche pas !**

Si on sniffe sur l'interface `h1-eth0` :

xterm
```
pef@palomino:~$ [h1] sudo tcpdump -lnvveX -i h1-eth0 not ip6
tcpdump: listening on h1-eth0, link-type EN10MB (Ethernet), snapshot length 262144
bytes
22:24:32.311172 be:f3:b3:20:e0:96 > ff:ff:ff:ff:ff:ff, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 192.168.20.1 tell 192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 bef3 b320 e096 c0a8  ...............
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
22:24:33.316526 be:f3:b3:20:e0:96 > ff:ff:ff:ff:ff:ff, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 192.168.20.1 tell 192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 bef3 b320 e096 c0a8  ...............
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
```

On voit bien l'étiquette VLAN ajoutée à la trame ARP, mais il n'y a pas de réponse

⟹ le paquet ne rejoint pas le VLAN 200...

⟹ **Notre isolation fonctionne.**

Seconde version de configuration VLAN : on va autoriser des paquets taggés VLAN

On modifie la connexion de `h1` sur le « *switch* » dans le fichier « `build_architecture` »:

```
ovs-vsctl add-port switch s1-h1 tag=100 vlan_mode=native-tagged
```

On configure sur `h1`, l'encapsulation VLAN pour rejoindre `h2` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l add link h1-eth0 name vers_vlan200 type
vlan id 200
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l set vers_vlan200 up
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 192.168.20.42/24 dev vers_vlan200
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
64 bytes from 192.168.20.1: icmp_seq=1 ttl=64 time=1.40 ms

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.396/1.396/1.396/0.000 ms
```

Dans une autre fenêtre sur `h1` :

xterm

```
pef@palomino:~$ [h1] sudo tcpdump -lnvveX -i h1-eth0 not ip6
tcpdump: listening on h1-eth0, link-type EN10MB (Ethernet), snapshot length 262144
bytes
22:52:21.391105 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 192.168.20.1 tell 192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
22:52:21.391919 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 192.168.20.1 is-at 5e:6d:ee:ba:fc:7b, length 28
        0x0000:  0001 0800 0604 0002 5e6d eeba fc7b c0a8  ........^m...{..
        0x0010:  1401 d2cc 44e8 3c6d c0a8 142a            ....D.<m...*
22:52:21.391933 d2:cc:44:e8:3c:6d > 5e:6d:ee:ba:fc:7b, ethertype 802.1Q (0x8100),
length 102: vlan 200, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 42702,
offset 0, flags [DF], proto ICMP (1), length 84)
    192.168.20.42 > 192.168.20.1: ICMP echo request, id 46535, seq 1, length 64
        0x0000:  4500 0054 a6ce 4000 4001 ea5e c0a8 142a  E..T..@.@..^...*
        0x0010:  c0a8 1401 0800 93a7 b5c7 0001 1560 4965  .............`Ie
        0x0020:  0000 0000 8bf7 0500 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
22:52:21.392447 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 102: vlan 200, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 7758,
offset 0, flags [none], proto ICMP (1), length 84)
    192.168.20.1 > 192.168.20.42: ICMP echo reply, id 46535, seq 1, length 64
        0x0000:  4500 0054 1e4e 0000 4001 b2df c0a8 1401  E..T.N..@.......
        0x0010:  c0a8 142a 0000 9ba7 b5c7 0001 1560 4965  ...*.........`Ie
        0x0020:  0000 0000 8bf7 0500 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
```

Ici, le trafic est encapsulé dans des trames VLANs $\Longrightarrow$ ça marche !

Par contre, si on essaye de "pinger" une patte externe du routeur :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
From 192.168.10.1 icmp_seq=1 Destination Host Unreachable

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 0 received, +1 errors, 100% packet loss, time 0ms


22:56:01.873244 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.10.254 tell
192.168.10.1, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  0a01 0000 0000 0000 c0a8 0afe            ............
22:56:01.873855 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 100, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 192.168.10.254 is-at 66:f1:76:90:a9:21, length 28
        0x0000:  0001 0800 0604 0002 66f1 7690 a921 c0a8  ........f.v..!..
        0x0010:  0afe d2cc 44e8 3c6d c0a8 0a01            ....D.<m....
```

La machine `h1` **n'interprète pas la trame avec l'encapsulation VLAN**

Ici, le port se comporte en "trunk", mais les paquets sortant vers `h1` (ceux du routeur) reçoivent une étiquette VLAN, ce qui perturbe `h1` !

Troisième version de configuration VLAN : on va autoriser des paquets taggés VLAN

On modifie la connexion de `h1` sur le « *switch* » dans le fichier « `build_architecture` » :

```
ovs-vsctl add-port switch s1-h1 tag=100 vlan_mode=native-untagged
```

On configure l'encapsulation VLAN sur `h1` pour rejoindre `h2` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l add link h1-eth0 name vers_vlan200 type
vlan id 200
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l set vers_vlan200 up
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 192.168.20.42/24 dev vers_vlan200
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 192.168.20.1
PING 192.168.20.1 (192.168.20.1) 56(84) bytes of data.
64 bytes from 192.168.20.1: icmp_seq=1 ttl=64 time=1.18 ms

--- 192.168.20.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.176/1.176/1.176/0.000 ms
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=1.09 ms

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.090/1.090/1.090/0.000 ms
```

Tout fonctionne !

La capture du trafic dans une autre fenêtre :

xterm

```
pef@palomino:~$ [h1] sudo tcpdump -lnvveX -i h1-eth0 not ip6
tcpdump: listening on h1-eth0, link-type EN10MB (Ethernet), snapshot length 262144
bytes
23:06:00.241368 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 192.168.20.1 tell 192.168.20.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 0000 0000 0000 c0a8 1401            .*..........
23:06:00.242007 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 192.168.20.1 is-at 5e:6d:ee:ba:fc:7b, length 28
        0x0000:  0001 0800 0604 0002 5e6d eeba fc7b c0a8  ........^m...{..
        0x0010:  1401 d2cc 44e8 3c6d c0a8 142a            ....D.<m...*
23:06:00.242023 d2:cc:44:e8:3c:6d > 5e:6d:ee:ba:fc:7b, ethertype 802.1Q (0x8100),
length 102: vlan 200, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 23291,
offset 0, flags [DF], proto ICMP (1), length 84)
    192.168.20.42 > 192.168.20.1: ICMP echo request, id 10437, seq 1, length 64
        0x0000:  4500 0054 5afb 4000 4001 3632 c0a8 142a  E..TZ.@.@.62...*
        0x0010:  c0a8 1401 0800 d1ef 28c5 0001 4863 4965  ........(...HcIe
        0x0020:  0000 0000 a9ae 0300 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:06:00.242497 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 102: vlan 200, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 21369,
offset 0, flags [none], proto ICMP (1), length 84)
    192.168.20.1 > 192.168.20.42: ICMP echo reply, id 10437, seq 1, length 64
        0x0000:  4500 0054 5379 0000 4001 7db4 c0a8 1401  E..TSy..@.}.....
        0x0010:  c0a8 142a 0000 d9ef 28c5 0001 4863 4965  ...*....(...HcIe
        0x0020:  0000 0000 a9ae 0300 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:06:05.348631 5e:6d:ee:ba:fc:7b > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 192.168.20.42 tell 192.168.20.1, length 28
        0x0000:  0001 0800 0604 0001 5e6d eeba fc7b c0a8  ........^m...{..
        0x0010:  1401 0000 0000 0000 c0a8 142a            ...........*
23:06:05.348656 d2:cc:44:e8:3c:6d > 5e:6d:ee:ba:fc:7b, ethertype 802.1Q (0x8100),
length 46: vlan 200, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 192.168.20.42 is-at d2:cc:44:e8:3c:6d, length 28
        0x0000:  0001 0800 0604 0002 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  142a 5e6d eeba fc7b c0a8 1401            .*^m...{....
23:06:09.253030 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.10.254 tell
192.168.10.1, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  0a01 0000 0000 0000 c0a8 0afe            ............
23:06:09.253631 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.10.254 is-at
66:f1:76:90:a9:21, length 28
        0x0000:  0001 0800 0604 0002 66f1 7690 a921 c0a8  ........f.v..!..
        0x0010:  0afe d2cc 44e8 3c6d c0a8 0a01            ....D.<m....
23:06:09.253644 d2:cc:44:e8:3c:6d > 66:f1:76:90:a9:21, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 6244, offset 0, flags [DF], proto ICMP (1), length
84)
    192.168.10.1 > 10.0.0.1: ICMP echo request, id 52196, seq 1, length 64
        0x0000:  4500 0054 1864 4000 4001 4d9b c0a8 0a01  E..T.d@.@.M.....
        0x0010:  0a00 0001 0800 96a2 cbe4 0001 5163 4965  ............QcIe
        0x0020:  0000 0000 38dc 0300 0000 0000 1011 1213  ....8...........
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:06:09.254074 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype IPv4 (0x0800),
length 98: (tos 0x0, ttl 64, id 761, offset 0, flags [none], proto ICMP (1), length
84)
    10.0.0.1 > 192.168.10.1: ICMP echo reply, id 52196, seq 1, length 64
        0x0000:  4500 0054 02f9 0000 4001 a306 0a00 0001  E..T....@.......
        0x0010:  c0a8 0a01 0000 9ea2 cbe4 0001 5163 4965  ............QcIe
        0x0020:  0000 0000 38dc 0300 0000 0000 1011 1213  ....8...........
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  ............ !"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:06:14.309074 66:f1:76:90:a9:21 > d2:cc:44:e8:3c:6d, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Request who-has 192.168.10.1 tell
192.168.10.254, length 28
        0x0000:  0001 0800 0604 0001 66f1 7690 a921 c0a8  ........f.v..!..
        0x0010:  0afe 0000 0000 0000 c0a8 0a01            ............
23:06:14.309096 d2:cc:44:e8:3c:6d > 66:f1:76:90:a9:21, ethertype ARP (0x0806),
length 42: Ethernet (len 6), IPv4 (len 4), Reply 192.168.10.1 is-at
d2:cc:44:e8:3c:6d, length 28
        0x0000:  0001 0800 0604 0002 d2cc 44e8 3c6d c0a8  ..........D.<m..
        0x0010:  0a01 66f1 7690 a921 c0a8 0afe            ..f.v..!....
```

Mais peut-on atteindre le réseau des routeurs depuis `h1` ?
On configure une nouvelle encapsulation VLAN pour rejoindre le réseau de routeurs `10.0.0.0/24` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l add link h1-eth0 name vers_vlan300 type
vlan id 300
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip l set vers_vlan300 up
pef@palomino:~/NET_LAB_VLAN$ [h1] sudo ip a add 10.0.0.42/24 dev vers_vlan300
pef@palomino:~/NET_LAB_VLAN$ [h1] ping -c 1 10.0.0.1
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=1.28 ms

--- 10.0.0.1 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 1.282/1.282/1.282/0.000 ms
```

Bien sûr !

La capture de trafic :

xterm

```
23:10:42.374270 d2:cc:44:e8:3c:6d > ff:ff:ff:ff:ff:ff, ethertype 802.1Q (0x8100),
length 46: vlan 300, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 10.0.0.1 tell 10.0.0.42, length 28
        0x0000:  0001 0800 0604 0001 d2cc 44e8 3c6d 0a00  ..........D.<m..
        0x0010:  002a 0000 0000 0000 0a00 0001            .*..........
23:10:42.374974 ca:10:a1:18:e0:b2 > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 300, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 10.0.0.1 is-at ca:10:a1:18:e0:b2, length 28
        0x0000:  0001 0800 0604 0002 ca10 a118 e0b2 0a00  ................
        0x0010:  0001 d2cc 44e8 3c6d 0a00 002a            ....D.<m...*
23:10:42.374990 d2:cc:44:e8:3c:6d > ca:10:a1:18:e0:b2, ethertype 802.1Q (0x8100),
length 102: vlan 300, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 28012,
offset 0, flags [DF], proto ICMP (1), length 84)
    10.0.0.42 > 10.0.0.1: ICMP echo request, id 10637, seq 1, length 64
        0x0000:  4500 0054 6d6c 4000 4001 b912 0a00 002a  E..Tml@.@......*
        0x0010:  0a00 0001 0800 961f 298d 0001 6264 4965  ........)...bdIe
        0x0020:  0000 0000 c8b5 0500 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:10:42.375498 ca:10:a1:18:e0:b2 > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 102: vlan 300, p 0, ethertype IPv4 (0x0800), (tos 0x0, ttl 64, id 28065,
offset 0, flags [none], proto ICMP (1), length 84)
    10.0.0.1 > 10.0.0.42: ICMP echo reply, id 10637, seq 1, length 64
        0x0000:  4500 0054 6da1 0000 4001 f8dd 0a00 0001  E..Tm...@.......
        0x0010:  0a00 002a 0000 9e1f 298d 0001 6264 4965  ...*....)...bdIe
        0x0020:  0000 0000 c8b5 0500 0000 0000 1011 1213  ................
        0x0030:  1415 1617 1819 1a1b 1c1d 1e1f 2021 2223  .............!"#
        0x0040:  2425 2627 2829 2a2b 2c2d 2e2f 3031 3233  $%&'()*+,-./0123
        0x0050:  3435 3637                                4567
23:10:47.460684 ca:10:a1:18:e0:b2 > d2:cc:44:e8:3c:6d, ethertype 802.1Q (0x8100),
length 46: vlan 300, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Request who-has 10.0.0.42 tell 10.0.0.1, length 28
        0x0000:  0001 0800 0604 0001 ca10 a118 e0b2 0a00  ................
        0x0010:  0001 0000 0000 0000 0a00 002a            ...........*
23:10:47.460716 d2:cc:44:e8:3c:6d > ca:10:a1:18:e0:b2, ethertype 802.1Q (0x8100),
length 46: vlan 300, p 0, ethertype ARP (0x0806), Ethernet (len 6), IPv4 (len 4),
Reply 10.0.0.42 is-at d2:cc:44:e8:3c:6d, length 28
        0x0000:  0001 0800 0604 0002 d2cc 44e8 3c6d 0a00  ..........D.<m..
        0x0010:  002a ca10 a118 e0b2 0a00 0001            .*..........
```

On a perdu toute isolation !!!
L'utilisateur peut faire du « *VLAN Hoping* » et sauter d'un VLAN à un autre.
⇒Il faut indiquer au switch les étiquettes VLAN autorisées.

Pour connaître les adresses MAC respectives et interpréter correctement la capture de `tcpdump` :

xterm

```
pef@palomino:~/NET_LAB_VLAN$ [h1] ip l
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode DEFAULT
group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: vers_vlan200@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP mode DEFAULT group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff
3: vers_vlan300@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP mode DEFAULT group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff
42: h1-eth0@if41: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
mode DEFAULT group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
pef@palomino:~/NET_LAB_VLAN$ [h1] ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: vers_vlan200@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff
    inet 192.168.20.42/24 scope global vers_vlan200
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
3: vers_vlan300@h1-eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue
state UP group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff
    inet 10.0.0.42/24 scope global vers_vlan300
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
42: h1-eth0@if41: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
group default qlen 1000
    link/ether d2:cc:44:e8:3c:6d brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.10.1/24 scope global h1-eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::d0cc:44ff:fee8:3c6d/64 scope link
       valid_lft forever preferred_lft forever
pef@palomino:~/NET_LAB_VLAN$ [h1] ip r
default via 192.168.10.254 dev h1-eth0
10.0.0.0/24 dev vers_vlan300 proto kernel scope link src 10.0.0.42
192.168.10.0/24 dev h1-eth0 proto kernel scope link src 192.168.10.1
192.168.20.0/24 dev vers_vlan200 proto kernel scope link src 192.168.20.42
```