

# iu-ne-lab-03-Iskander\_Nafikov

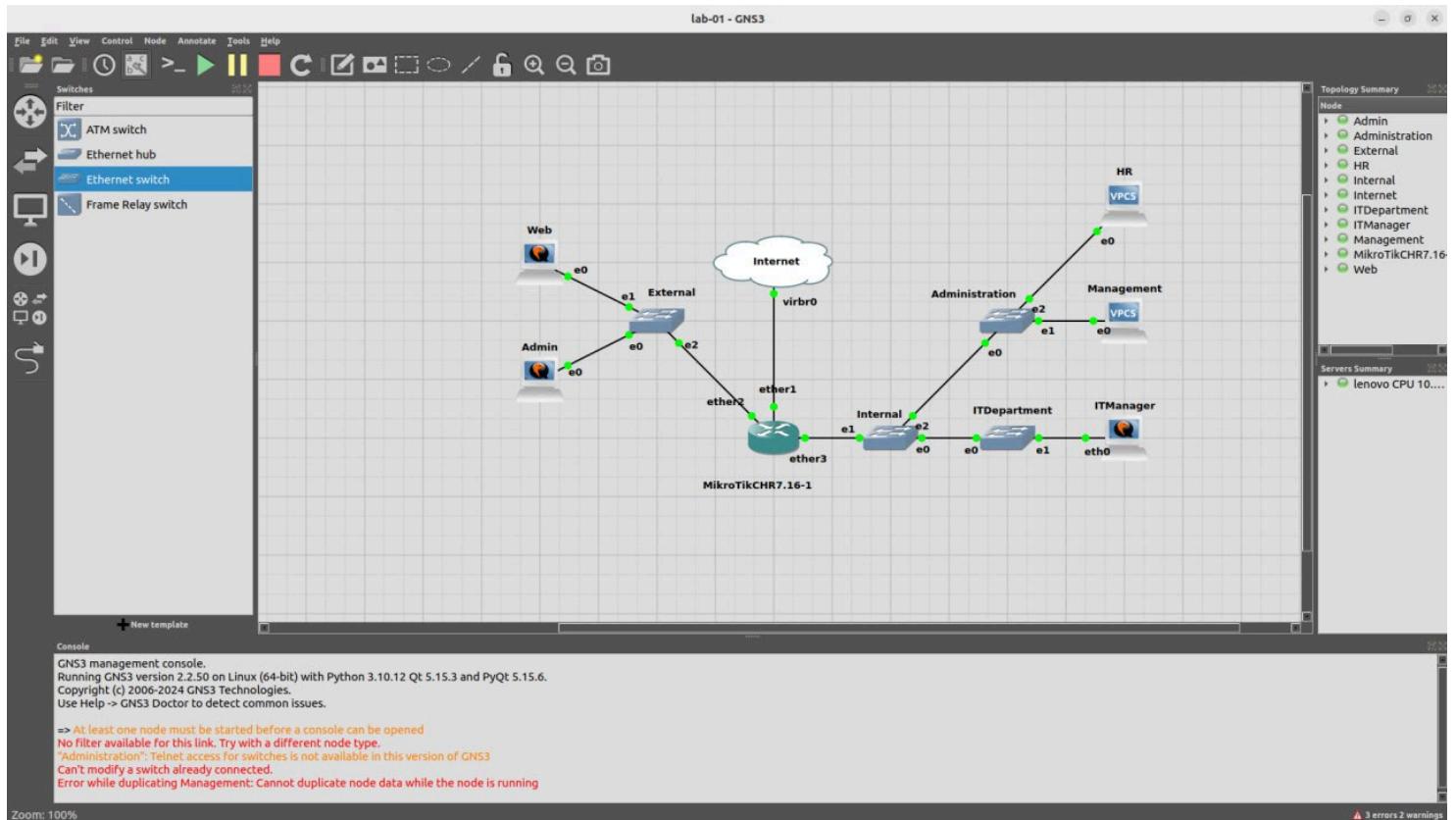
- **Name:** Iskander Nafikov
- **E-mail:** [i.nafikov@innopolis.university](mailto:i.nafikov@innopolis.university)
- **Username:** [iskanred](#)
- **Hostname:** lenovo

## 1. Preparation

The preparations were done. I used Mikrotik router.

## 2. VLANs

- a. Change the topology of your network to as follows, and make the necessary configurations.
- I made a topology as [follows](#) also added changes to the topology from the previous labs (i.e. changed name of "Worker" node to "ITManager"). The results are the following:



- b. Configure the switches and make sure you have connectivity between the hosts.

- I checked the connectivity between ITManager and Management & HR

```

root@ITManager:~# echo "My (ITManager) address:"; ifconfig | grep "inet 10"
My (ITManager) address:
    inet 10.1.1.2 netmask 255.255.255.0 broadcast 0.0.0.0
root@ITManager:~# echo "Ping Management"; ping 10.1.1.3
Ping Management
PING 10.1.1.3 (10.1.1.3) 56(84) bytes of data.
64 bytes from 10.1.1.3: icmp_seq=1 ttl=64 time=0.925 ms
64 bytes from 10.1.1.3: icmp_seq=2 ttl=64 time=0.801 ms
64 bytes from 10.1.1.3: icmp_seq=3 ttl=64 time=0.660 ms
^C
--- 10.1.1.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2035ms
rtt min/avg/max/mdev = 0.660/0.795/0.925/0.108 ms
root@ITManager:~# echo "Ping HR:"; ping 10.1.1.4
Ping HR:
PING 10.1.1.4 (10.1.1.4) 56(84) bytes of data.
64 bytes from 10.1.1.4: icmp_seq=1 ttl=64 time=1.63 ms
64 bytes from 10.1.1.4: icmp_seq=2 ttl=64 time=0.639 ms
64 bytes from 10.1.1.4: icmp_seq=3 ttl=64 time=0.673 ms
^C--- 10.1.1.4 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2048ms
rtt min/avg/max/mdev = 0.639/0.980/1.630/0.459 ms
root@ITManager:~#

```

Running GNS3 version 2.2.59 on Linux (64-bit) with Python 3.10.12 Qt 5.15.3 and PyQt 5.15.6.  
Copyright (c) 2006-2024 GNS3 Technologies.  
Use Help -> GNS3 Doctor to detect common issues.

Cannot resolve 10.1.1.1...  
Management> echo Ping ITManager  
Ping ITManager  
Management> ping 10.1.1.2  
84 bytes from 10.1.1.2 icmp\_seq=1 ttl=64 time=0.686 ms  
84 bytes from 10.1.1.2 icmp\_seq=2 ttl=64 time=0.785 ms  
^C  
Management> echo Ping HR  
Ping HR  
Management> ping 10.1.1.4  
84 bytes from 10.1.1.4 icmp\_seq=1 ttl=64 time=0.446 ms  
84 bytes from 10.1.1.4 icmp\_seq=2 ttl=64 time=0.561 ms  
^C  
Management> show ip

```

NAME      : Management[1]
IP/MASK   : 10.1.1.3/24
GATEWAY   : 10.1.1.1
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10043
RHOST:PORT: 127.0.0.1:10044
MTU      : 1500

```

Running GNS3 version 2.2.59 on Linux (64-bit) with Python 3.10.12 Qt 5.15.3 and PyQt 5.15.6.  
Copyright (c) 2006-2024 GNS3 Technologies.  
Use Help -> GNS3 Doctor to detect common issues.

- Between Management and ITManager and HR

```

Trying 127.0.0.1...
Connected to localhost.
Escape character is '^}'.

Cannot resolve 10.1.1.1...  
Management> echo Ping ITManager  
Ping ITManager  
Management> ping 10.1.1.2  
84 bytes from 10.1.1.2 icmp_seq=1 ttl=64 time=0.686 ms  
84 bytes from 10.1.1.2 icmp_seq=2 ttl=64 time=0.785 ms  
^C  
Management> echo Ping HR  
Ping HR  
Management> ping 10.1.1.4  
84 bytes from 10.1.1.4 icmp_seq=1 ttl=64 time=0.446 ms  
84 bytes from 10.1.1.4 icmp_seq=2 ttl=64 time=0.561 ms  
^C  
Management> show ip
```

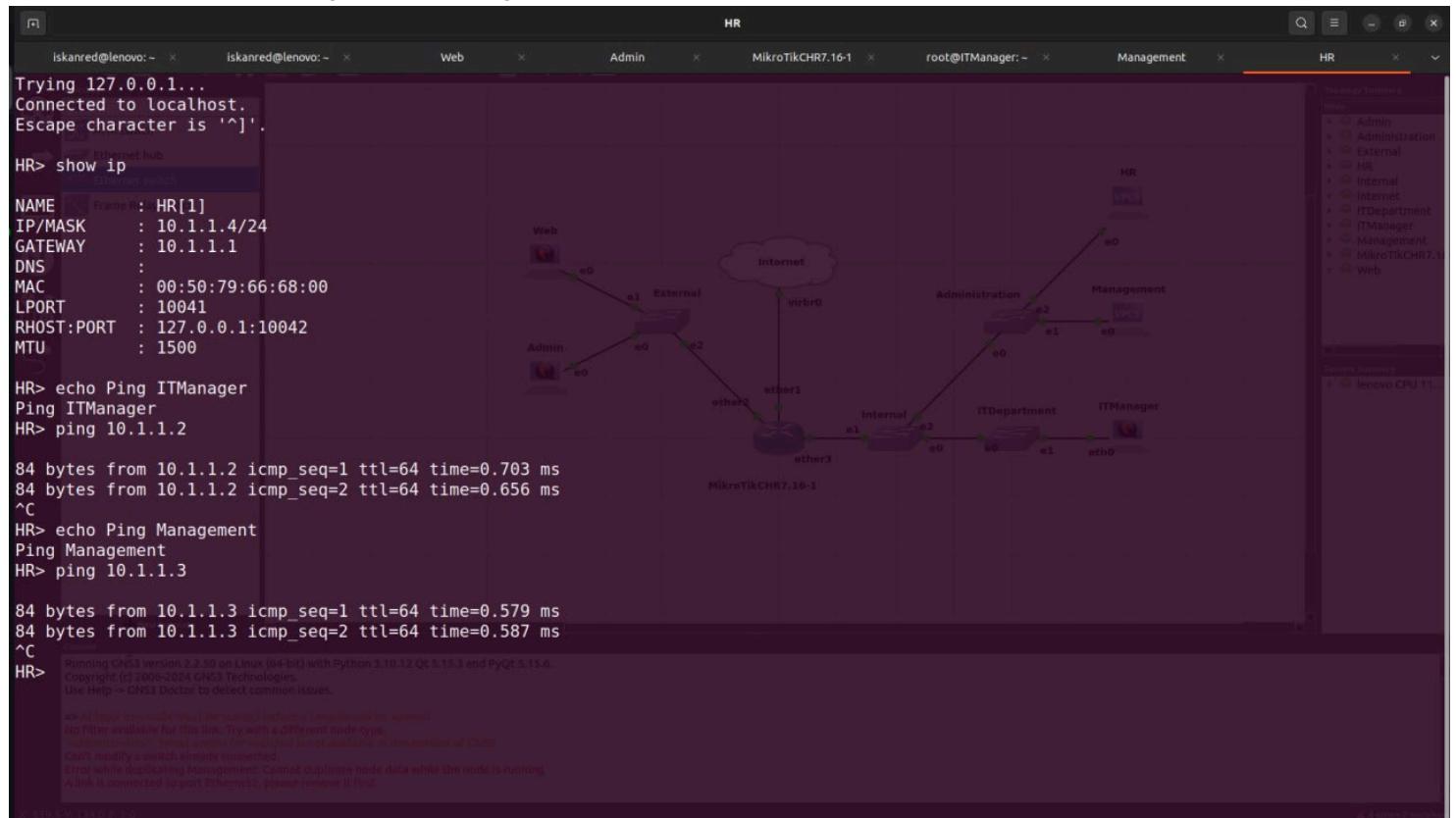
```

NAME      : Management[1]
IP/MASK   : 10.1.1.3/24
GATEWAY   : 10.1.1.1
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10043
RHOST:PORT: 127.0.0.1:10044
MTU      : 1500

```

Running GNS3 version 2.2.59 on Linux (64-bit) with Python 3.10.12 Qt 5.15.3 and PyQt 5.15.6.  
Copyright (c) 2006-2024 GNS3 Technologies.  
Use Help -> GNS3 Doctor to detect common issues.

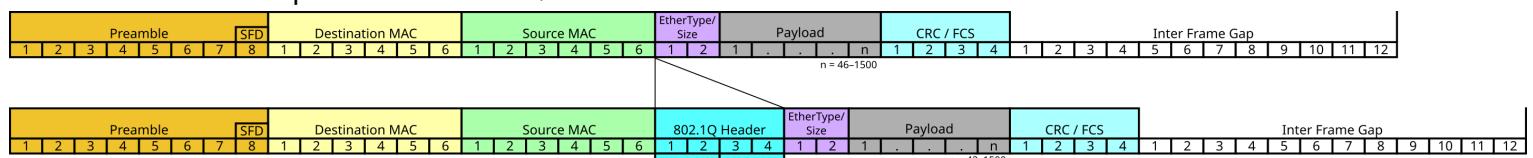
## • Between HR and ITManager and Management



c. How do VLANs work at a packet level? What are the two main protocols used for this?

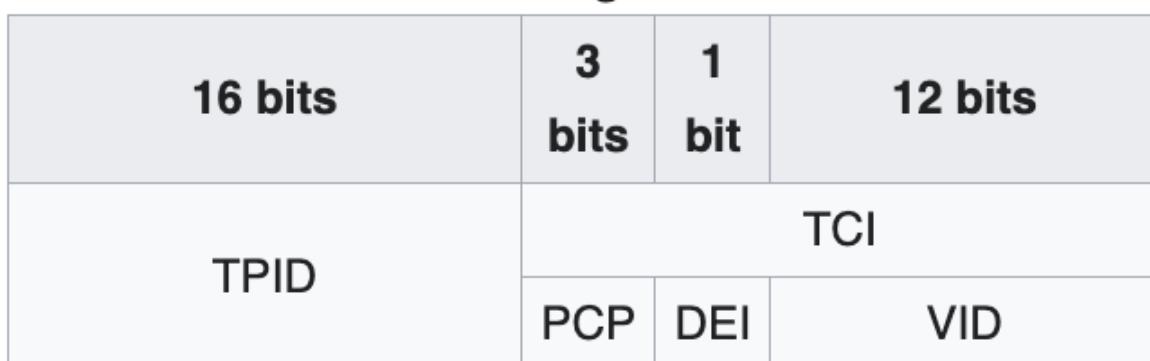
**VLAN** is a technology that exists only in 2nd OSI-layer (Link layer). Therefore, it is not correct to mention working at a "packet" level, since packets are entities of the 3rd OSI-layer (Network layer). The more convenient would be to use word "frames". **Note:** Actually it can exist above the 2nd layer, but it is not related to IEEE 802.1Q, so I will not consider it

The frames contains special IEEE 802.1Q header



This header has the following structure:

**802.1Q tag format**



Where:

- **TPID** = Tag protocol identifier: A 16-bit field set to a value of 0x8100 in order to identify the frame as an IEEE 802.1Q-tagged frame.

- **TCI** = Tag control information: A 16-bit field containing several sub-fields. The most interesting sub-field for us is:
  - **VID** = VLAN identifier: A 12-bit field specifying the VLAN to which the frame belongs.

Marking a frame with different **VID** is the same as making them belonging to different VLANs.

The main protocols used:

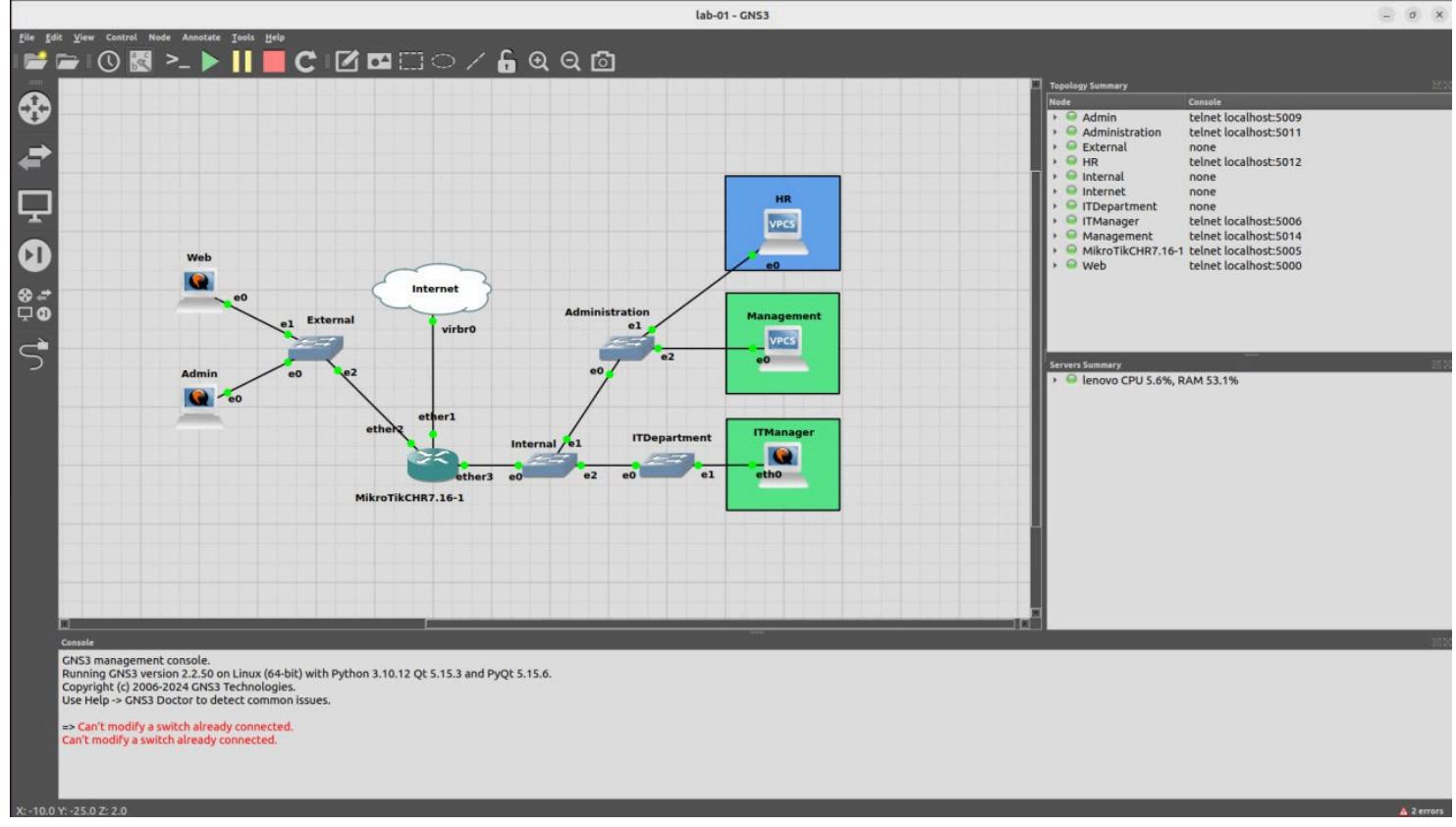
- **IEEE 802.1Q (or Dot1Q)**
- **Q-in-Q (or IEEE 802.1ad)** which is an extension to 802.1Q and it allows two or more VLAN headers in the same frame

#### d. What is the Native VLAN?

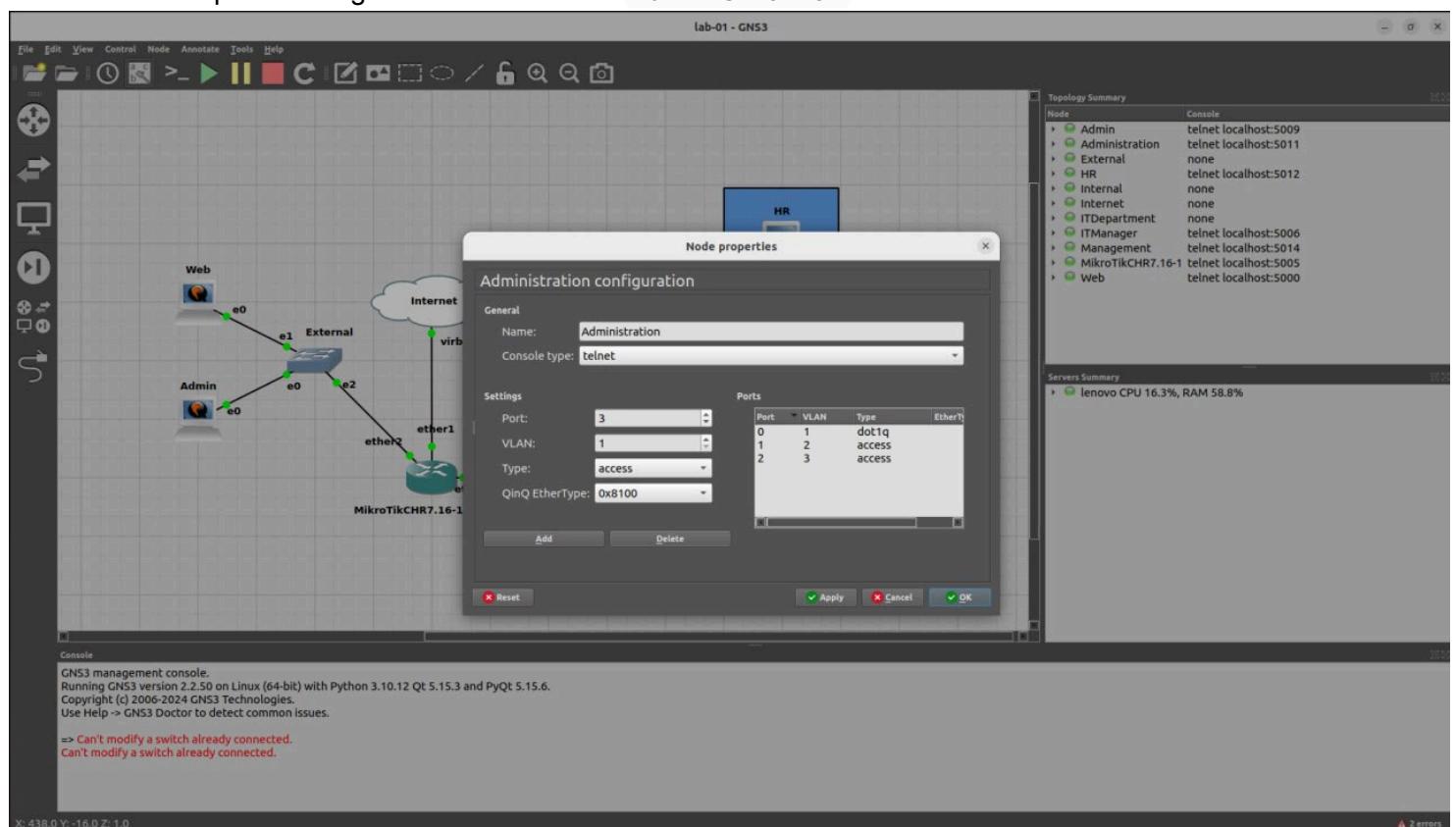
**Native VLAN** is a concept in the [802.1Q](#) standard that designates a VLAN on a switch where all frames go without a tag, i.e. traffic is transmitted untagged. By default, this is VLAN 1. In some switch models, such as Cisco, this can be changed by specifying another VLAN as native. The network switch automatically adds the labels of this VLAN to all received frames that do not have any labels. VLANs based on ports have some limitations. Only one VLAN can receive all the untagged frames!

#### e. Configure the VLANs on the switches to isolate the two virtual networks as follow.

- I configured the topology as follows (some changes in port's names because of switches reconfiguration):



- Here is an example of configuration of the switch Administration



f. Ping between ITManager and HR, do you have replies? Ping between ITManager and Management, do you have replies? Can you see the VLAN ID in Wireshark?

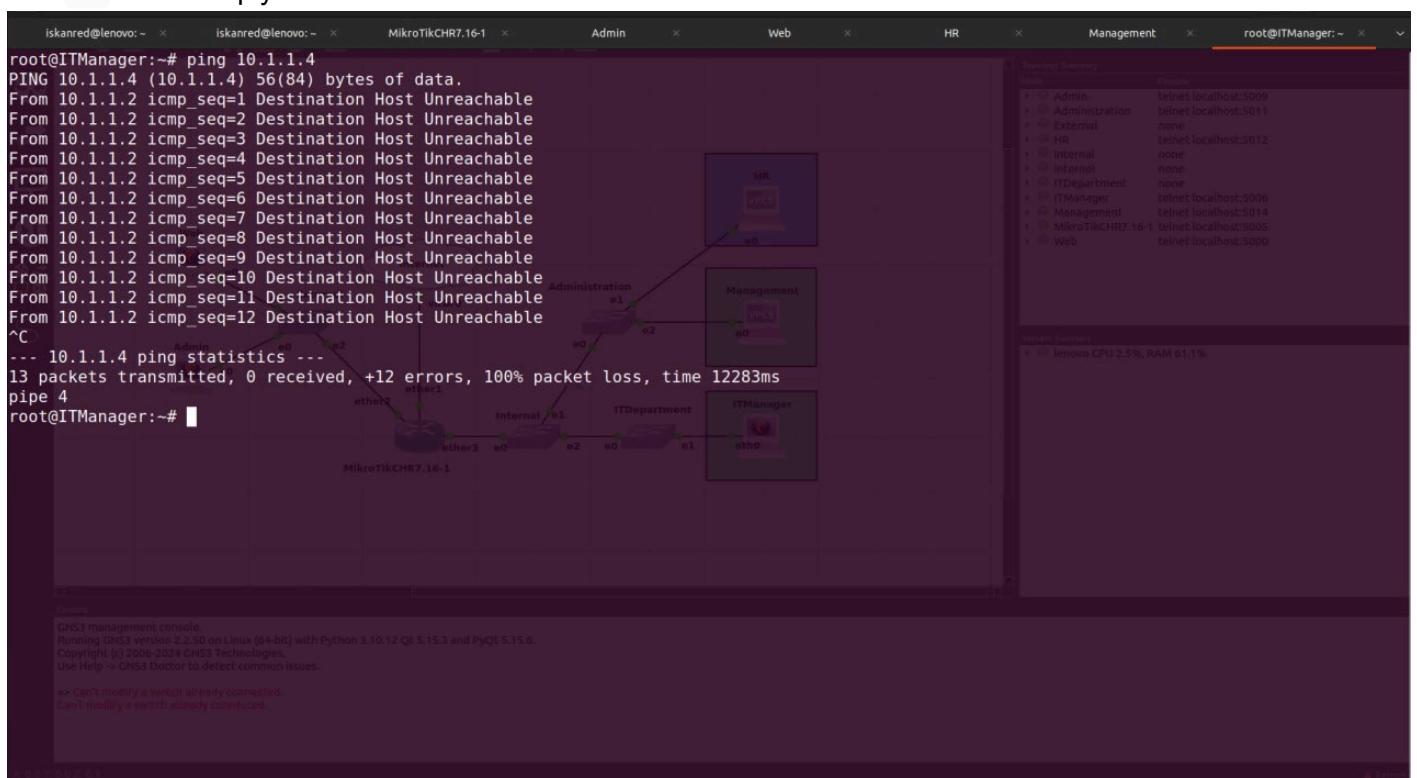
- Ping between ITManager and HR :

- The address of HR remained the same

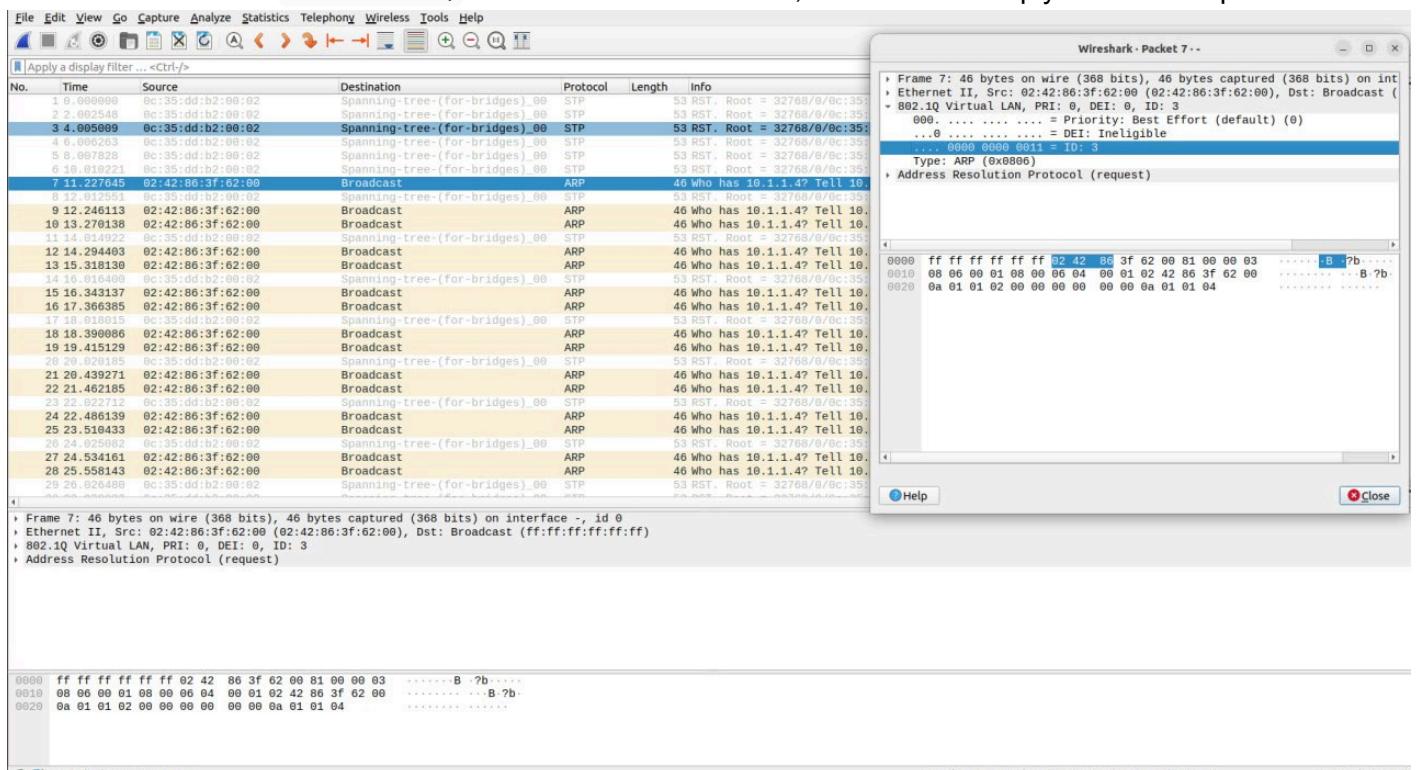
```
HR> show ip

NAME          : HR[1]
IP/MASK       : 10.1.1.4/24
GATEWAY      : 10.1.1.1
DNS           : 10.1.1.1
MAC           : 00:50:79:66:68:00
LPORT         : 10041
RHOST:PORT   : 127.0.0.1:10042
MTU           : 1500
```

- The HR did not reply



- I decided to capture the traffic of the link between switch Internal and Administration. There we can see that ARP frames had IEEE 802.1Q ID = 3 of VLAN. However, there were no reply for these requests.



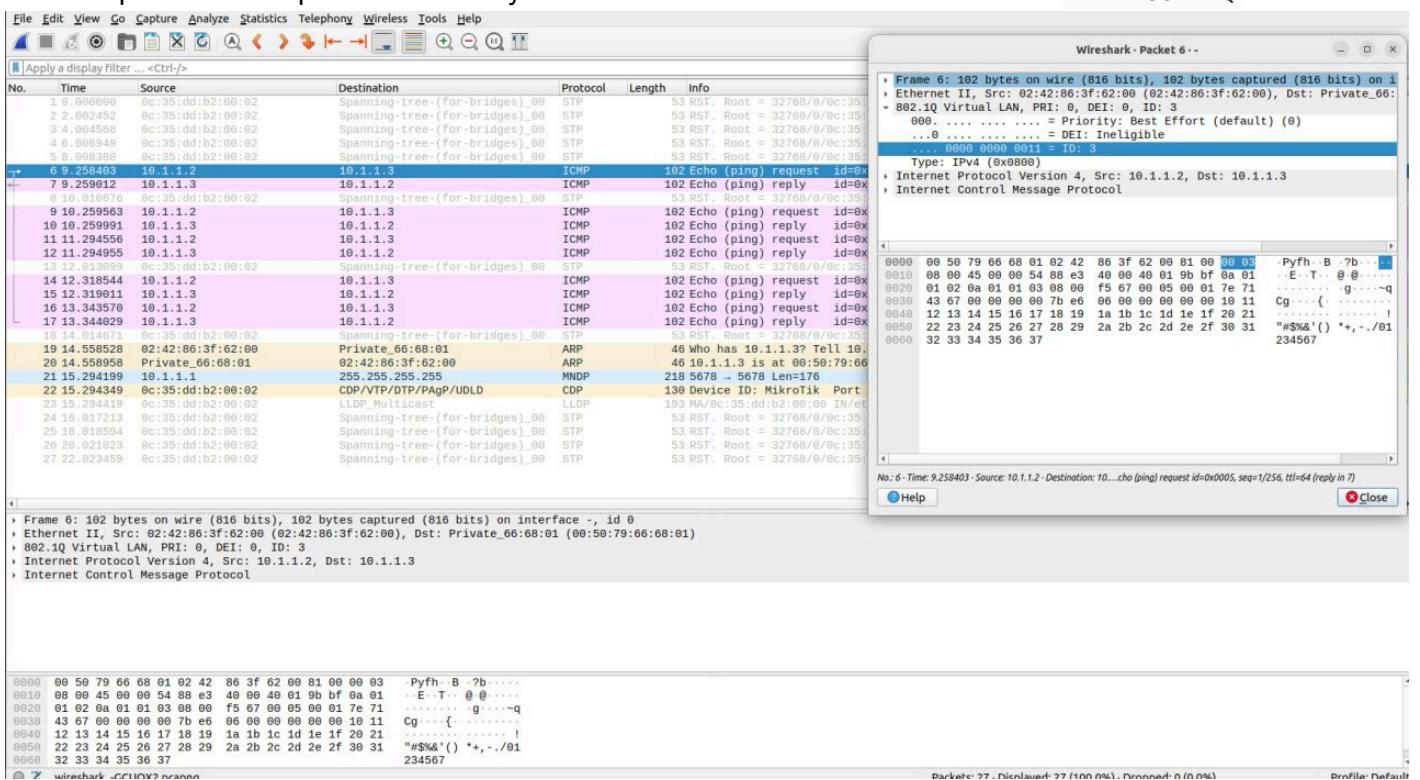
- Ping between ITManager and Management . The same is applicable here the result is the opposite though:

- The address of Management remained the same

```
Management> show ip
Internet Control Message Protocol
NAME      : Management[1]
IP/MASK   : 10.1.1.3/24
GATEWAY   : 10.1.1.1
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10043
RHOST:PORT: 127.0.0.1:10044
MTU      : 1500
```

- The Management did reply!

- ICMP requests were replied successfully. Inside their frames we can see the same IEEE 802.1Q ID = 3



### g. Configure Inter-VLAN Routing between Management VLAN and HR VLAN and Show that you can now ping between them.

I faced a **problem** with my configuration after configuring Inter-VLAN communication. The problem was that the router always tried to make ARP broadcast requests to the **wrong VLAN**:

- For example, I tried 10.1.1.2 which was on VLAN = 3. However, the router continued searching for this IP with ARP broadcast requests tagging its frame with ID= 2 and vice versa!
- I realized that the problem had been in that router had the same address for three interfaces: simple bridge2 , VLAN2 , VLAN3

```
[admin@mikrotik] > ip route print
Flags: D - DYNAMIC; A - ACTIVE; c - CONNECT, d - DHCP; + - ECMP
Columns: DST-ADDRESS, GATEWAY, DISTANCE
      DST-ADDRESS          GATEWAY          DISTANCE
DAd  0.0.0.0/0           192.168.122.1        1
DAc+ 10.1.1.0/24        bridge2            0
DAc+ 10.1.1.0/24        VLAN2              0
DAc+ 10.1.1.0/24        VLAN3              0
DAc  10.1.2.0/24        bridge1            0
DAc  192.168.122.0/24   ether1             0
[admin@mikrotik] >
```

- Of course, there always been a confusion since the router using its internal algorithm chose some of the available interfaces and the choice had always been wrong 😢

```

[admin@MikroTik] > ip arp print
Flags: D - DYNAMIC; C - COMPLETE
Columns: ADDRESS, MAC-ADDRESS, INTERFACE, STATUS
# ADDRESS MAC-ADDRESS INTERFACE STATUS
0 DC 10.1.2.3 0C:8B:74:6A:00:00 bridge1 stale
1 DC 10.1.1.4 00:50:79:66:68:00 VLAN2 stale
2 DC 10.1.1.3 00:50:79:66:68:01 VLAN3 stale
3 DC 192.168.122.1 52:54:00:82:2B:47 ether1 stale
4 DC 10.1.2.2 0C:EB:82:E3:00:00 bridge1 stale
[admin@MikroTik] > ping 10.1.1.2
SEQ HOST
  0 10.1.1.2
  1 10.1.1.2
sent=2 received=0 packet-loss=100%
[admin@MikroTik] > ping 10.1.1.3
SEQ HOST
  0 10.1.1.3
  sent=1 received=0 packet-loss=100%

```

```

[admin@MikroTik] > ip arp print
Flags: D - DYNAMIC; C - COMPLETE
Columns: ADDRESS, MAC-ADDRESS, INTERFACE, STATUS
# ADDRESS MAC-ADDRESS INTERFACE STATUS
0 DC 10.1.2.3 0C:8B:74:6A:00:00 bridge1 stale
1 DC 10.1.1.4 00:50:79:66:68:00 VLAN2 stale
2 DC 10.1.1.3 00:50:79:66:68:01 VLAN3 stale
3 DC 192.168.122.1 52:54:00:82:2B:47 ether1 stale
4 DC 10.1.2.2 0C:EB:82:E3:00:00 bridge1 stale
5 D 10.1.1.2 dynamic 2015-07-01 00:00:00.000000000
6 D 10.1.1.3 dynamic 2015-07-01 00:00:00.000000000

```

- Therefore, I decided to **change the subnets** for each of the VLANs to: 10.1.12.0/24 for VLAN2 and 10.1.13.0/24 for VLAN3

- Below is my **old** configuration

```

[admin@mikrotik] > ip address print
Flags: D - DYNAMIC
Columns: ADDRESS, NETWORK, INTERFACE
# ADDRESS NETWORK INTERFACE
0 10.1.2.1/24 10.1.2.0 bridge1
1 10.1.1.1/24 10.1.1.0 bridge2
2 D 192.168.122.129/24 192.168.122.0 ether1
3 10.1.1.1/24 10.1.1.0 VLAN2
4 10.1.1.1/24 10.1.1.0 VLAN3
[admin@mikrotik] > interface vlan print
Flags: R - RUNNING
Columns: NAME, MTU, ARP, VLAN-ID, INTERFACE
# NAME MTU ARP VLAN-ID INTERFACE
0 R VLAN2 1500 enabled 2 bridge2
1 R VLAN3 1500 enabled 3 bridge2
[admin@mikrotik] > interface print
Flags: R - RUNNING; S - SLAVE
Columns: NAME, TYPE, ACTUAL-MTU, L2MTU, MAC-ADDRESS
# NAME TYPE ACTUAL-MTU L2MTU MAC-ADDRESS
0 R ether1 ether 1500 0C:35:DD:B2:00:00
1 RS ether2 ether 1500 0C:35:DD:B2:00:01
2 RS ether3 ether 1500 0C:35:DD:B2:00:02
3 ether4 ether 1500 0C:35:DD:B2:00:03
4 ether5 ether 1500 0C:35:DD:B2:00:04
5 ether6 ether 1500 0C:35:DD:B2:00:05
6 ether7 ether 1500 0C:35:DD:B2:00:06
7 ether8 ether 1500 0C:35:DD:B2:00:07
8 R VLAN2 wlan 1500 65531 0C:35:DD:B2:00:02
9 R VLAN3 wlan 1500 65531 0C:35:DD:B2:00:02
10 R bridge1 bridge 1500 65535 0C:35:DD:B2:00:01
11 R bridge2 bridge 1500 65535 0C:35:DD:B2:00:02
12 R lo loopback 65536 00:00:00:00:00:00

```

- So now, the configuration had been changed to:

```
MikroTikCHR7.16-1 Admin Web HR Management root@ITManager:~
```

```
[admin@MikroTik] > ip address set address=10.1.12.1/24 numbers=3
[admin@MikroTik] > ip address set address=10.1.13.1/24 numbers=4
[admin@MikroTik] > ip address print
Flags: D - DYNAMIC
Columns: ADDRESS, NETWORK, INTERFACE
# ADDRESS NETWORK INTERFACE
0 10.1.2.1/24 10.1.2.0 bridge1
1 10.1.1.1/24 10.1.1.0 bridge2
2 D 192.168.122.129/24 192.168.122.0 ether1
3 10.1.12.1/24 10.1.12.0 VLAN2
4 10.1.13.1/24 10.1.13.0 VLAN3
[admin@MikroTik] > interface vlan print
Flags: R - RUNNING
Columns: NAME, MTU, ARP, VLAN-ID, INTERFACE
# NAME MTU ARP VLAN-ID INTERFACE
0 R VLAN2 1500 enabled 2 bridge2
1 R VLAN3 1500 enabled 3 bridge2
[admin@MikroTik] > interface print
Flags: R - RUNNING; S - SLAVE
Columns: NAME, TYPE, ACTUAL-MTU, L2MTU, MAC-ADDRESS
# NAME TYPE ACTUAL-MTU L2MTU MAC-ADDRESS
0 R ether1 ether 1500 0C:35:DD:B2:00:00
1 RS ether2 ether 1500 0C:35:DD:B2:00:01
2 RS ether3 ether 1500 0C:35:DD:B2:00:02
3 ether4 ether 1500 0C:35:DD:B2:00:03
4 ether5 ether 1500 0C:35:DD:B2:00:04
5 ether6 ether 1500 0C:35:DD:B2:00:05
6 ether7 ether 1500 0C:35:DD:B2:00:06
7 ether8 ether 1500 0C:35:DD:B2:00:07
8 R VLAN2 vlan 1500 65531 0C:35:DD:B2:00:02
9 R VLAN3 vlan 1500 65531 0C:35:DD:B2:00:02
10 R bridge1 bridge 1500 65535 0C:35:DD:B2:00:01
11 R bridge2 bridge 1500 65535 0C:35:DD:B2:00:02
12 R lo loopback 65536 00:00:00:00:00:00
[admin@MikroTik] >
[admin@MikroTik] >
[admin@MikroTik] >
```

- Moreover, after that I had to **change the IP** addresses on my nodes Management , HR and ITManager

- HR

- Management

The screenshot shows the MikroTik CHR7.16-1 Management interface. The top navigation bar includes tabs for Admin, Web, HR, Management, and root@ITManager:. The Management tab is active.

Terminal window output:

```
Management> ip 10.1.13.2/24 10.1.13.1
Checking for duplicate address...
Management : 10.1.13.2 255.255.255.0 gateway 10.1.13.1

Management> show ip

NAME      : Management[1]
IP/MASK   : 10.1.13.2/24
GATEWAY   : 10.1.13.1
DNS       :
MAC       :
LPORT     : 10043
RHOST:PORT: 127.0.0.1:10044
MTU      : 1500

Management>
```

Bottom status bar:

```
Management> ns3 version 2.2.50 on Linux (64-bit) with Python 3.10.12 Qt 5.15.3 and PyQt 5.15.6.
Management> 2006-2024 CNCF Technologies.
Management> NS3 Doctor to detect common issues.
Management> If a switch already connected.
Management> If a switch already connected.
Management>
Management>
Management>
Management>
```

- ITManager

The figure shows a terminal window with several tabs and a GNS3 network diagram.

**Terminal Output:**

```
root@ITManager:~# ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 10.1.13.3 netmask 255.255.255.0 broadcast 0.0.0.0
inet6 2001:db9::2 prefixlen 64 scopeid 0x0<global>
inet6 fe80::42:86ff:fe3f:6200 prefixlen 64 scopeid 0x20<link>
ether 02:42:86:3f:62:00 txqueuelen 1000 (Ethernet)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 9 bytes 842 (842.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

root@ITManager:~#
```

**GNS3 Network Diagram:**

- MikroTikCHR7.16-1:** A central router-like node with two interfaces:
  - External:** Connected to the **External** port of the **Management** switch.
  - Management:** Connected to the **Management** port of the **ITManager** switch.
- Management:** A switch with three ports:
  - External:** Connected to the **External** port of the **MikroTikCHR7.16-1** router.
  - Internal:** Connected to the **Internal** port of the **ITDepartment** switch.
  - Management:** Connected to the **Management** port of the **ITManager** switch.
- ITDepartment:** A switch with two ports:
  - Internal:** Connected to the **Internal** port of the **Management** switch.
  - ITManager:** Connected to the **ITManager** port of the **ITManager** switch.
- ITManager:** A switch with two ports:
  - Management:** Connected to the **Management** port of the **MikroTikCHR7.16-1** router.
  - ITManager:** Connected to the **ITManager** port of the **ITDepartment** switch.

**System Overview:**

- Admin:** telnet localhost:5009
- Administration:** telnet localhost:5011
- External:** none
- HR:** telnet localhost:5012
- Internal:** none
- Internet:** none
- ITDepartment:** none
- ITManager:** telnet localhost:5014
- Management:** telnet localhost:5005
- MikroTikCHR7.16-1:** telnet localhost:5005
- Web:** telnet localhost:5000

**Services Summary:**

- lenovo CPU 2.1%, RAM 68.0%

**GNS3 Management Console:**

Running GNS3 version 2.2.50 on Linux (64-bit) with Python 3.10.12 QF 5.15.3 and PyQt 5.15.6.  
Copyright (c) 2006-2024 GNS3 Technologies.  
Use Help > GNS3 Doctor to detect common issues.

» Can't modify a switch already connected.  
Can't modify a switch already connected.

- Finally, I was able to perform ping from Management to HR and vice a versa:

- Ping from HR

```

isikanred@lenovo:~ isikanred@lenovo:~ MikroTikCHR7.16-1 Admin Web HR Management root@ITManager:~ HR> show ip
NAME      : HR[1]
IP/MASK   : 10.1.12.2/24
GATEWAY   : 10.1.12.1
DNS       :
MAC       : 00:50:79:66:68:00
LPORT     : 10041
RHOST:PORT: 127.0.0.1:10042
MTU       : 1500
HR> ping 10.1.13.2
84 bytes from 10.1.13.2 icmp_seq=1 ttl=63 time=2.928 ms
^C
HR> ping 10.1.13.3
84 bytes from 10.1.13.3 icmp_seq=1 ttl=63 time=3.200 ms
^C
HR>
HR>
HR>
HR>
HR>
HR>
HR>
HR>
HR> CnNS3 management console.
HR> Running CnNS3 version 2.2.350 on Linux (64-bit) with Python 3.10.12 QL 5.15.3 and PyQt 5.15.6.
HR> Copyright (c) 2006-2024 CnNS3 Technologies.
HR> User Help --> CnNS3 Doctor to detect common issues.
HR> >>> Can't modify a switch already connected.
HR> >>> Can't modify a switch already connected.
HR>
HR>
HR> MikroTikCHR7.16-1

```

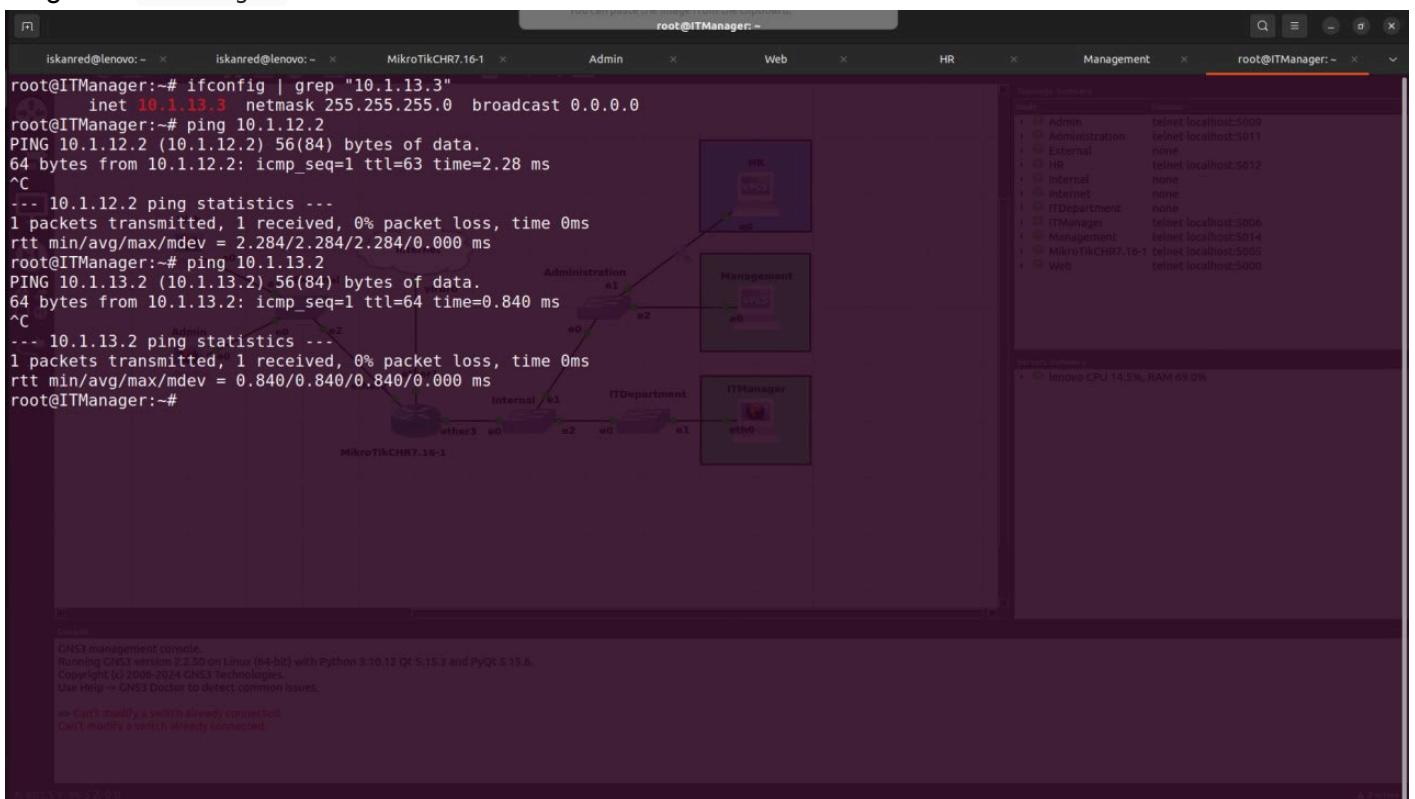
- Ping from Management

```

isikanred@lenovo:~ isikanred@lenovo:~ MikroTikCHR7.16-1 Admin Web HR Management root@ITManager:~ Management> show ip
NAME      : Management[1]
IP/MASK   : 10.1.13.2/24
GATEWAY   : 10.1.13.1
DNS       :
MAC       : 00:50:79:66:68:01
LPORT     : 10043
RHOST:PORT: 127.0.0.1:10044
MTU       : 1500
Management> ping 10.1.12.2
84 bytes from 10.1.12.2 icmp_seq=1 ttl=63 time=2.274 ms
^C
Management> ping 10.1.13.3
84 bytes from 10.1.13.3 icmp_seq=1 ttl=64 time=0.523 ms
^C
Management>
Management> CnNS3 management console.
Management> Running CnNS3 version 2.2.350 on Linux (64-bit) with Python 3.10.12 QL 5.15.3 and PyQt 5.15.6.
Management> Copyright (c) 2006-2024 CnNS3 Technologies.
Management> User Help --> CnNS3 Doctor to detect common issues.
Management> >>> Can't modify a switch already connected.
Management> >>> Can't modify a switch already connected.
Management>
Management>
Management>
Management> MikroTikCHR7.16-1

```

- Ping from ITManager



- And we can see that ARP table in the router was updated correctly

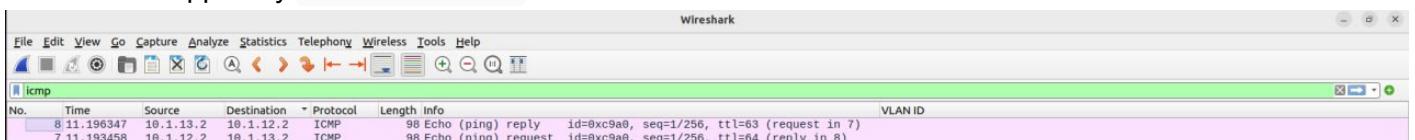
```
MikroTikCHR7.16-1

[admin@MikroTik] > ip arp print
Flags: D - DYNAMIC; C - COMPLETE
Columns: ADDRESS, MAC-ADDRESS, INTERFACE, STATUS
#  ADDRESS      MAC-ADDRESS      INTERFACE  STATUS
0  DC 10.1.2.3  0C:BB:74:6A:00:00  bridge1   stale
1  DC 192.168.122.1 52:54:00:82:2B:47  ether1    stale
2  DC 10.1.2.2  0C:EB:B2:E3:00:00  bridge1   stale
3  DC 10.1.12.2 00:50:79:66:68:00  VLAN2    stale
4  DC 10.1.13.2 00:50:79:66:68:01  VLAN3    stale
5  DC 10.1.13.3 02:42:86:3F:62:00  VLAN3    stale

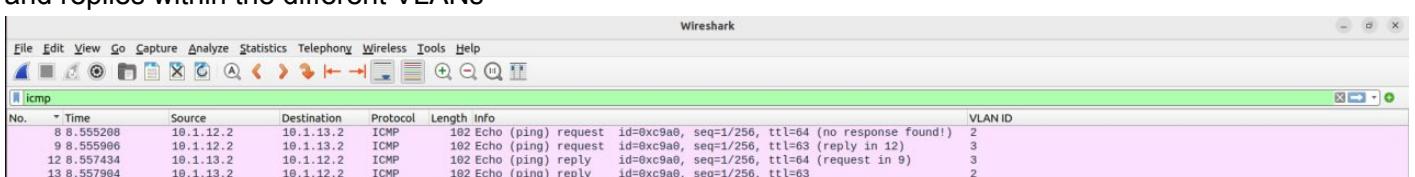
[admin@MikroTik] > ip route print
Flags: D - DYNAMIC; A - ACTIVE; c - CONNECT, d - DHCP
Columns: DST-ADDRESS, GATEWAY, DISTANCE
  DST-ADDRESS      GATEWAY      DISTANCE
DAd 0.0.0.0/0      192.168.122.1  1
DAc 10.1.1.0/24    bridge2      0
DAc 10.1.2.0/24    bridge1      0
DAc 10.1.12.0/24   VLAN2       0
DAc 10.1.13.0/24   VLAN3       0
DAc 192.168.122.0/24  ether1      0
```

- What is interesting is that now in Wireshark we can see the ICMP request from the HR to Management twice

- Below is capturing of the link HR – Administration . Here we have no VLAN ID in the header since it is added and stripped by Administration switch.



- However, if we look at the link Administration – Internal we will notice that there are two ICMP requests and replies within the different VLANs



- And that is an evidence that both the request and response were transferred across the Administration switch twice: before and after being routed into different VLAN

- The request's path

HR → Administration (VID = 2) → Internal (VID = 2) → Router (VID = 2) → Router (VID = 3) → Internal (VID = 3) → Administration (VID = 2) → Management

- The reply's path

Management → Administration (VID = 2) → Internal (VID = 3) → Router (VID = 3) → Router (VID = 2) → Internal (VID = 2) → Administration (VID = 2) → HR

## 3. Fault Tolerance

- a. What is Link Aggregation? How does it work (briefly)? What are the possible configuration modes?

### Definition

**Link aggregation** is a concept from **IEEE 802.1AX** (IEEE 802.3ad in the past, but no longer related **only** to Ethernet) that provides a way of using a bunch of links to increase performance of transmission and/or to ensure fault tolerance. In this context such links may exist as real links between the same two devices using different ports. On the other hand, these links could be two different devices acting as one (to achieve it clients must use Cisco VSS or Nexus VCC proprietary protocols). A group of ports combined together is called a **link aggregation group**, or LAG (bond, team, or port-channel in different implementations) with maximum of 8 links in a group. The rule that defines which packets are sent along which link is called the **scheduling algorithm**. The active monitoring protocol that allows devices to include or remove individual links from the LAG is called **Link Aggregation Control Protocol** (LACP).

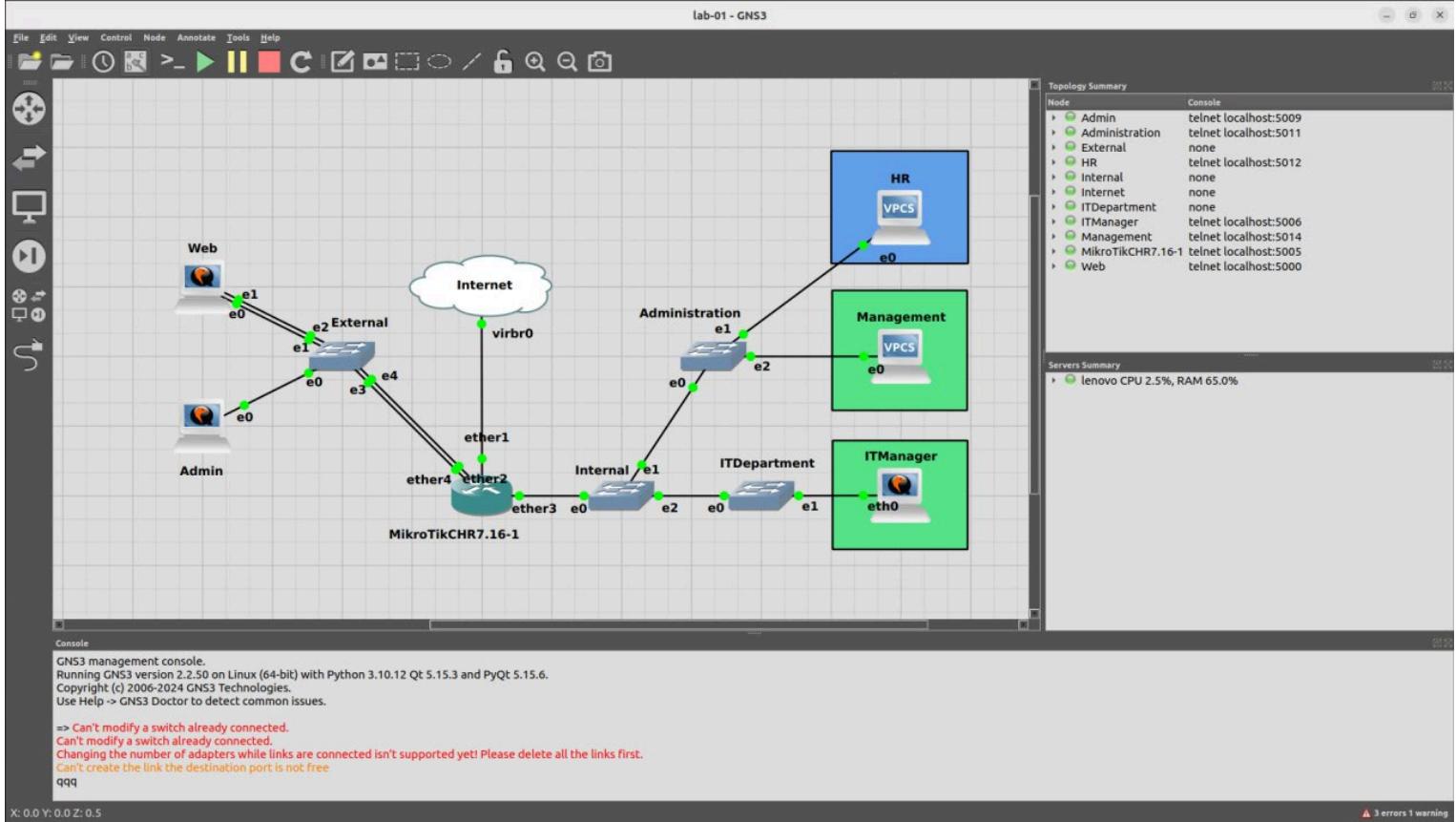
### How it works?

LACP works by sending frames (LACPDUs) down all links that have the protocol enabled. If it finds a device on the other end of a link that also has LACP enabled, that device will independently send frames along the same links in the opposite direction enabling the two units to detect multiple links between themselves and then combine them into a single logical link. LACP can be configured in one of two modes: active or passive. In active mode, LACPDUs are sent 1 per second along the configured links. In passive mode, LACPDUs are not sent until one is received from the other side, a speak-when-spoken-to protocol.

### Configuration modes

The configuration modes may include:

- **Scheduling** (load-balancing) algorithm. **Example:** MAC-address hashing (L2), IP-address hashing (L3), socket hashing (L4), round-robin, other. It must be selected according utilisation.
  - **Active or passive** (or merely on), equivalently, to use LACP or not to use (e.g. to use PAgP in Cisco). The **active** option means the device will actively monitor the state of the link and automatically remove any failed links from the bundle. However, the other device may not support LACP, so it can lead to the situation when one device will keep dumping packets down a link that the other device isn't watching.
- b. Use link aggregation between the Web and the Gateway to have Load Balancing and Fault Tolerance as follows.



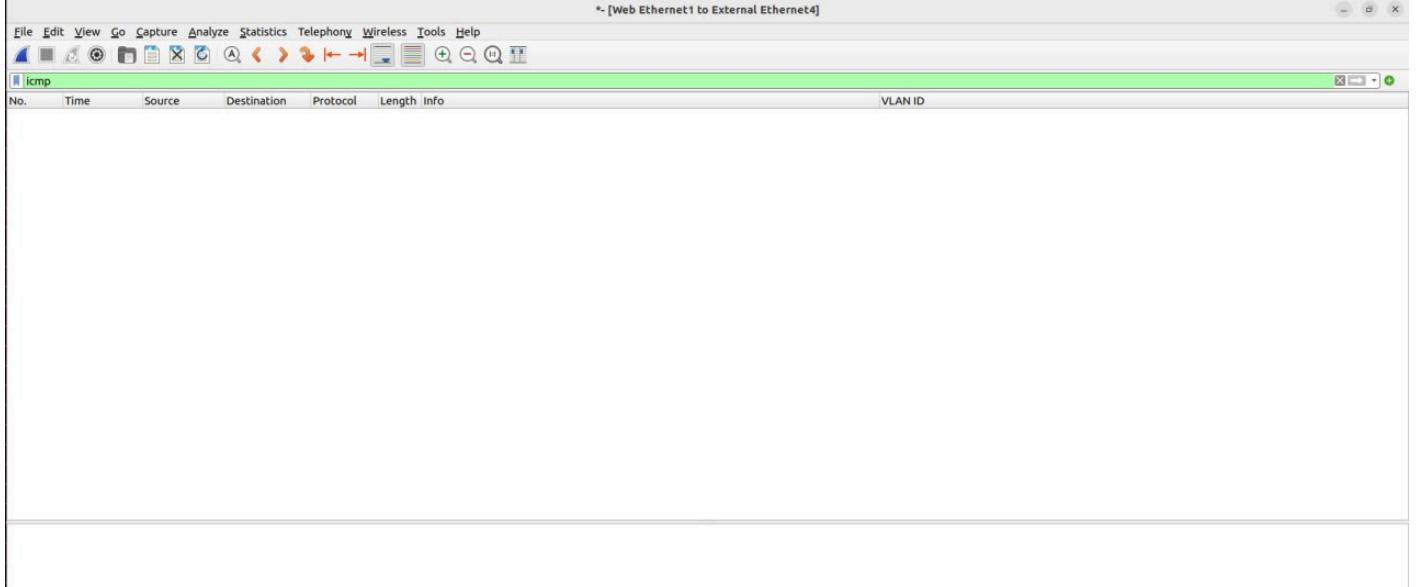
- If we put just one more link for each of the parts of the path from the Web to the Gateway we will get such a picture:
  - All the traffic goes through one of the links constantly for both Web – External (switch) and External (switch) – Mikrotik (router)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000889	10.1.2.1	10.1.2.2	ICMP	88	Echo (ping) request id=0x3f9, seq=84/4784, ttl=64 (request in 2)
2	0.000978	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=184/47104, ttl=64 (request in 1)
3	1.001270	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=185/47366, ttl=64 (reply in 5)
4	1.001569	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=185/47366, ttl=64 (request in 4)
5	2.003589	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=186/47616, ttl=64 (reply in 7)
6	2.003727	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=186/47616, ttl=64 (request in 6)
7	3.004643	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=187/47872, ttl=64 (reply in 10)
8	3.005257	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=187/47872, ttl=64 (request in 9)
9	4.006761	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=188/48128, ttl=64 (reply in 12)
10	4.007396	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=188/48128, ttl=64 (request in 11)
11	5.008899	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=189/48384, ttl=64 (reply in 15)
12	5.008732	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=189/48384, ttl=64 (request in 14)
13	6.009545	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=190/48640, ttl=64 (reply in 17)
14	6.010259	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=190/48640, ttl=64 (request in 16)
15	7.011122	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=191/48896, ttl=64 (reply in 28)
16	7.011863	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=191/48896, ttl=64 (request in 19)
17	8.012346	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=192/49152, ttl=64 (reply in 22)
18	8.012980	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=192/49152, ttl=64 (request in 21)
19	9.014120	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=193/49408, ttl=64 (reply in 25)
20	9.014876	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=193/49408, ttl=64 (request in 24)
21	10.016691	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=194/49664, ttl=64 (reply in 27)
22	10.016788	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=194/49664, ttl=64 (request in 26)
23	11.017830	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=195/49920, ttl=64 (reply in 30)
24	11.018623	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=195/49920, ttl=64 (request in 29)
25	12.019896	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=196/50176, ttl=64 (reply in 32)
26	12.020613	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=196/50176, ttl=64 (request in 31)
27	13.020782	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=197/50432, ttl=64 (reply in 35)
28	13.021413	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=197/50432, ttl=64 (request in 34)
29	14.022644	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=198/50888, ttl=64 (reply in 44)
30	14.023281	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=198/50888, ttl=64 (request in 43)
31	15.024594	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=199/50844, ttl=64 (reply in 47)
32	16.025496	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=199/50844, ttl=64 (request in 46)
33	16.026160	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=200/51200, ttl=64 (reply in 49)
34	16.026160	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=200/51200, ttl=64 (request in 48)

No.	Time	Source	Destination	Protocol	Length	Info	VLAN ID
112	39.067822	10.1.2.1	10.1.2.2	ICMP	98	Echo (ping) reply id=0x3f9, seq=242/61952, ttl=64 (request in 1)	
113	40.069118	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=243/62208, ttl=64 (reply in 1)	
114	40.069724	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=243/62208, ttl=64 (request in 1)	
115	40.069724	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=244/62464, ttl=64 (reply in 1)	
116	41.071306	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=244/62464, ttl=64 (request in 1)	
117	41.079814	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=245/62720, ttl=64 (reply in 1)	
118	42.073126	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=245/62720, ttl=64 (request in 1)	
119	42.073782	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=245/62720, ttl=64 (reply in 1)	
120	43.074387	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=246/62976, ttl=64 (request in 1)	
121	43.074387	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=246/62976, ttl=64 (reply in 1)	
122	43.074933	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=247/63232, ttl=64 (request in 1)	
123	44.075496	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=248/63488, ttl=64 (reply in 1)	
124	44.076081	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=248/63488, ttl=64 (request in 1)	
125	45.077500	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=249/63744, ttl=64 (reply in 1)	
126	45.078671	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=249/63744, ttl=64 (request in 1)	
127	46.078749	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=250/64000, ttl=64 (reply in 1)	
128	46.087993	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=250/64000, ttl=64 (request in 1)	
129	47.088109	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=251/64000, ttl=64 (reply in 1)	
130	47.088735	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=251/64000, ttl=64 (request in 1)	
131	48.081918	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=252/64256, ttl=64 (reply in 1)	
132	48.082648	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=252/64256, ttl=64 (request in 1)	
133	48.083657	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=252/64512, ttl=64 (reply in 1)	
134	48.084394	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=252/64512, ttl=64 (request in 1)	
135	49.085424	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=253/64768, ttl=64 (reply in 1)	
136	49.086668	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=253/64768, ttl=64 (request in 1)	
137	50.087668	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=254/65024, ttl=64 (reply in 1)	
138	51.088735	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=254/65024, ttl=64 (request in 1)	
139	52.089781	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=255/65280, ttl=64 (reply in 1)	
140	52.089781	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=255/65280, ttl=64 (request in 1)	
141	53.089129	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=256/65536, ttl=64 (reply in 149)	
142	53.089741	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=256/65536, ttl=64 (request in 149)	
143	54.091342	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=257/65792, ttl=64 (reply in 152)	
144	54.091896	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=257/65792, ttl=64 (request in 152)	
145	54.092324	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=258/6513, ttl=64 (reply in 161)	
146	55.093791	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=258/6513, ttl=64 (request in 161)	
147	55.094651	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=259/769, ttl=64 (reply in 164)	
148	56.095771	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=259/769, ttl=64 (request in 164)	
149	56.096532	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=259/769, ttl=64 (reply in 1)	

- While other links do not see any traffic

No.	Time	Source	Destination	Protocol	Length	Info	VLAN ID
151	49.091342	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=256/1, ttl=64 (request in 148)	
152	50.092324	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=256/1, ttl=64 (request in 148)	
153	54.091896	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=257/257, ttl=64 (reply in 152)	
154	54.092324	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=257/257, ttl=64 (request in 152)	
155	55.094651	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=258/513, ttl=64 (reply in 161)	
156	56.095771	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=258/513, ttl=64 (request in 161)	
157	56.096532	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) request id=0x3f9, seq=259/769, ttl=64 (reply in 164)	
158	56.096532	10.1.2.2	10.1.2.1	ICMP	98	Echo (ping) reply id=0x3f9, seq=259/769, ttl=64 (request in 164)	



- So, let's firstly put a new bonding interface to our router which will combine ether2 and ether4 as slaves.
    - Let's have a look at the configuration of the router ( 10.1.2.1/24 ) with added bonding interface:

```
[admin@nikroTik] > interface bond print
Flags: X - disabled; R - running
0 R name="bond2" mtu=1500 mac-address=0C:35:DD:B2:00:01 arp-enabled arp-timeout=auto slaves=ether2,ether4 mode=balance-rr primary=None link-monitoring-mil arp-interval=100ms arp-ip-targets="" mil-interval=100ms down-delay=0ms up-delay=0ms lacp-rate=30secs transmit-hash-policy=layer-2 min-links=0
[admin@nikroTik] > interface print
Flags: R - RUNNING; S - SLAVE
Columns: NAME, TYPE, ACTUAL-MTU, L2MTU, MAC-ADDRESS
# NAME TYPE ACTUAL-MTU L2MTU MAC-ADDRESS
0 R ether1 ether 1500 0C:35:DD:B2:00:00
1 RS ether2 ether Web 1500 0C:35:DD:B2:00:01
2 RS ether3 ether 1500 0C:35:DD:B2:00:02
3 RS ether4 ether 1500 0C:35:DD:B2:00:03
4 ether5 ether 1500 0C:35:DD:B2:00:04
5 ether6 ether 1500 0C:35:DD:B2:00:05
6 ether7 ether 1500 0C:35:DD:B2:00:06
7 ether8 ether 1500 0C:35:DD:B2:00:07
8 R VLAN2 vlan 1500 65531 0C:35:DD:B2:00:02
9 R VLAN3 vlan 1500 65531 0C:35:DD:B2:00:02
10 R bond2 bond 1500 1500 0C:35:DD:B2:00:01
11 R bridge3 bridge 1500 65535 0C:35:DD:B2:00:02
12 R lo loopback 65536 00:00:00:00:00:00
[admin@nikroTik] > ip address print
Flags: D - DYNAMIC Admin
Columns: ADDRESS, NETWORK, INTERFACE
# ADDRESS NETWORK INTERFACE
0 10.1.13.1/24 10.1.13.0 VLAN3 MikroTikCHR7.16-1
1 D 192.168.122.129/24 192.168.122.0 ether1
2 10.1.12.1/24 10.1.12.0 VLAN2
3 10.1.2.1/24 10.1.2.0 bond2
[admin@nikreTik] > ip route print
Flags: D - DYNAMIC; A - ACTIVE; c - CONNECT, d - DHCP
Columns: DST-ADDRESS, GATEWAY, DISTANCE
DAd 0.0.0.0/0 management 192.168.122.1 1
DAc 10.1.2.0/24 bond2 0
DAc 10.1.12.0/24 Doctor 0
DAc 10.1.13.0/24 VLAN3 0
DAc 192.168.122.0/24 ether1 0

```

- The default algorithm of load balancing for a bonding interface in Mikrotik is balance-rr which is a simple Round Robin algorithm.

```
[admin@mikroTik] > interface bonding print ether1
Flags: X - disabled; R - running
0 R name="bond2" mtu=1500 mac-address=0C:35:DD:B2:00:01 arp=enabled arp-timeout=auto slaves=ether2,ether4 mode=balance-rr primary=None
    link-monitoring=mii arp-interval=100ms arp-ip-targets="" mii-interval=100ms down-delay=0ms up-delay=0ms lacp-rate=30secs
    transmit-hash-policy=layer-2 min-links=0
[admin@mikroTik] > interface bonding monitor 0
    mode: balance-rr
    active-ports: ether2,ether4
    inactive-ports:

[admin@mikroTik] > interface bonding monitor-slaves 0
input does not match any value of bond
[admin@mikroTik] > interface bonding monitor-slaves bond2
Flags: A - active; P - partner
A port=ether2
A port=ether4
```

- Also, let's take a look at the configuration of the Web node (10.1.2.2/24). For now it's important just to check it, the reasons will be considered after.

```

ubuntu@ubuntu-cloud:~$ ifconfig | grep 10.1
  inet 10.1.2.2  brd 255.255.255.0  broadcast 10.1.2.255
  inet 10.1.2.2  netmask 255.255.255.0  broadcast 10.1.2.255
ubuntu@ubuntu-cloud:~$ sudo cat /etc/netplan/50-cloud-init.yaml
network:
  version: 2
  ethernets:
    e0:
      match:
        macaddress: "0c:eb:82:e3:00:00"
      dhcp4: no
      dhcp6: no
      addresses:
        - 10.1.2.2/24
        - "2001:db8::b/64"
      routes:
        - to: default
          via: 10.1.2.1
        - to: "::/0"
          via: "2001:db8::1"
          on-link: yes
      set-name: "e0"
    nameservers:
      addresses:
        - 1.1.1.1
        - 8.8.8.8
    e1:
      match:
        macaddress: "0c:eb:82:e3:00:01"
      dhcp4: no
      dhcp6: no
      addresses:
        - 10.1.2.2/24
        - "2001:db8::b/64"
      routes:
        - to: default
          via: 10.1.2.1
        - to: "::/0"
          via: "2001:db8::1"
          on-link: yes
      set-name: "e1"
    nameservers:
      addresses:
        - 1.1.1.1

```

Sniffer summary table:

Role	Device	Config
Admin	telnet localhost:5409	
Administration	telnet localhost:5911	
External	none	
HR	telnet localhost:5012	
Internal	none	
Internet	none	
ITDepartment	none	
ITManager	telnet localhost:5006	
Management	telnet localhost:5014	
MikroTikCHR7.16-1	telnet localhost:5003	
web	telnet localhost:5000	

- Let's check if it works

- Let's perform ping from the Router to the Web

```

iskanred@lenovo:~ -> iskanred@lenovo:~ -> MikroTikCHR7.16-1 -> Web -> Admin -> HR -> Management -> root@ITManager:~ ->
[admin@mikrotik] > interface bond print
Flags: X - disabled; R - running
0 R name="bond2" mtu=1500 mac-address=0C:35:DD:DB:2B:00:01 arp-enabled arp-timeout=auto slaves=ether2,ether4 mode=balance-rr primary=None
link-monitoring=mii arp-interval=100ms arp-ip-targets="" mii-interval=100ms down-delay=0ms up-delay=0ms lacp-rate=30secs
transmit-hash-policy=layer-2 min-links=0
[admin@mikrotik] > ip address print
Flags: D - DYNAMIC
Columns: ADDRESS, NETWORK, INTERFACE
# ADDRESS           NETWORK           INTERFACE
0 10.1.13.1/24     10.1.13.0       VLAN3
1 D 192.168.122.129/24 192.168.122.0   ether1
2 10.1.12.1/24     10.1.12.0       VLAN2
3 10.1.2.1/24     10.1.2.0       bond2
[admin@mikrotik] > ping 10.1.2.2
SEQ HOST          10.1.2.2  10.1.2.1  SIZE TTL TIME STATUS
  0 10.1.2.2 10.1.2.1 78 Echo (ping) reply 10.0.0.100, seq=12/2, ttl=64 (request in 60)
  1 10.1.2.2 10.1.2.1 78 Echo (ping) request 10.0.0.100, seq=70/3, ttl=255 (reply in 62)
  2 10.1.2.2 10.1.2.1 78 Echo (ping) reply 10.0.0.100, seq=12/4, ttl=64 (request in 63)
  3 10.1.2.2 10.1.2.1 78 Echo (ping) request 10.0.0.100, seq=70/5, ttl=255 (reply in 64)
  4 10.1.2.2 10.1.2.1 78 Echo (ping) reply 10.0.0.100, seq=12/5, ttl=64 (request in 65)
  5 10.1.2.2          78 Echo (ping) reply 10.0.0.100, seq=70/6, ttl=255 (reply in 66)
  6 10.1.2.2 10.1.2.1 78 Echo (ping) reply 10.0.0.100, seq=12/6, ttl=64 (request in 67)
  7 10.1.2.2 10.1.2.1 78 Echo (ping) request 10.0.0.100, seq=70/7, ttl=255 (reply in 68)
  8 10.1.2.2 10.1.2.1 78 Echo (ping) message Protocol
  9 10.1.2.2          56 64 lms560us
 10 10.1.2.2          56 64 lms282us
 11 10.1.2.2          56 64 lms348us
 12 10.1.2.2          56 64 lms593us
 13 10.1.2.2          56 64 lms362us
 14 10.1.2.2 00:0c:eb:82:e3:00 56 64 lms351us
 15 10.1.2.2 00:ff:e1:e4:a8:a1 56 64 lms439us
 16 10.1.2.2 54:b1:00:00:00:ab:aa:06:20 56 64 lms395us
sent=17 received=17 packet-loss=0% min-rtt=lms282us avg-rtt=lms492us max-rtt=lms761us

[admin@mikrotik] > 

```

- We can notice that all ICMP traffic was equally divided between two links that are located between the nodes Router - Switch .

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\* [External Ethernet2 to MikroTikCHR7.6-1 ether2]

icmp

No.	Time	Source	Destination	Protocol	Length	Info
69	99.221591	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=256/4, ttl=64 (request in 68)
71	101.226157	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=768/3, ttl=255 (reply in 72)
72	101.226826	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=768/3, ttl=64 (request in 71)
73	103.232099	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1280/5, ttl=255 (reply in 74)
74	103.232776	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1280/5, ttl=64 (request in 73)
76	104.235416	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1536/6, ttl=255 (reply in 77)
77	104.236126	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1536/6, ttl=64 (request in 76)
78	106.231973	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2048/8, ttl=255 (reply in 79)
79	106.232833	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2048/8, ttl=64 (request in 78)
83	108.228689	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2560/16, ttl=255 (reply in 84)
84	108.228267	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2560/16, ttl=64 (request in 83)
85	110.230268	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3072/12, ttl=255 (reply in 86)
86	110.230294	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3072/12, ttl=64 (request in 85)
87	112.230897	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3584/14, ttl=255 (reply in 88)
88	112.231557	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3584/14, ttl=64 (request in 87)
89	114.227140	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=4096/16, ttl=255 (reply in 98)
90	114.227899	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=4096/16, ttl=64 (request in 89)

> Frame 68: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface -, id 0

> Ethernet II, Src: 0c:eb:82 (0c:eb:82:e3:00:00), Dst: 0c:eb:82:e3:00:00 (0c:eb:82:e3:00:00)

> Internet Protocol Version 4, Src: 10.1.2.1, Dst: 10.1.2.2

> Internet Control Message Protocol

No.	Time	Source	Destination	Protocol	Length	Info
0000	0c eb 82 e3 00 00 0c 35 dd b2 00 01 00 00 45 00				5	E-
0010	09 38 bf 60 00 00 ff 01 04 57 0a 01 02 01 00 01				8 h	W ...
0020	02 02 08 00 cd df b1 00 01 00 81 ac aa aa d7 2e				12 h	U ...
0030	57 55 02 07 86 ac 59 0a 0d 32 73 64 97 bf d3 d8				2sd	WU ... Y- ...
0040	fb ff cc ad 44 52				V ... R	

Internet Control Message Protocol: Protocol

Packets: 108 - Displayed: 18 (16.7%)

Profile: Default

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icmp

No.	Time	Source	Destination	Protocol	Length	Info
64	98.217717	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=0/0, ttl=255 (reply in 65)
65	99.218449	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=0/0, ttl=64 (request in 64)
68	100.223317	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=512/2, ttl=255 (reply in 69)
69	100.224092	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=512/2, ttl=64 (request in 68)
70	102.228621	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1024/4, ttl=255 (reply in 71)
71	102.229324	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1024/4, ttl=64 (request in 70)
73	105.228450	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1792/7, ttl=255 (reply in 74)
74	105.229209	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1792/7, ttl=64 (request in 73)
75	107.235340	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2304/9, ttl=255 (reply in 76)
76	107.236114	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2304/9, ttl=64 (request in 75)
78	109.231400	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2816/11, ttl=255 (reply in 79)
79	109.232089	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2816/11, ttl=64 (request in 78)
80	111.227738	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3328/13, ttl=255 (reply in 81)
81	111.228425	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3328/13, ttl=64 (request in 80)
82	113.233875	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3840/15, ttl=255 (reply in 83)
83	113.234559	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3840/15, ttl=64 (request in 82)

Ready to load or capture

Packets: 137 - Displayed: 16 (11.7%)

Profile: Default

- However, the distribution between the links Switch - Web remained the same (only one link transmitted all the frames).

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icmp

No.	Time	Source	Destination	Protocol	Length	Info
60	82.086986	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=512/2, ttl=64 (request in 50)
61	83.088987	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=768/3, ttl=255 (reply in 62)
62	83.089540	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=768/3, ttl=64 (request in 61)
63	84.091624	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1024/4, ttl=255 (reply in 64)
64	84.092288	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1024/4, ttl=64 (request in 63)
65	85.094928	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1280/5, ttl=255 (reply in 66)
66	85.095594	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1280/5, ttl=64 (request in 65)
69	86.098250	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1536/6, ttl=255 (reply in 70)
70	86.098812	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1536/6, ttl=64 (request in 69)
71	87.091468	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=1792/7, ttl=255 (reply in 72)
72	87.092108	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=1792/7, ttl=64 (request in 71)
73	88.093191	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2048/8, ttl=255 (reply in 74)
74	88.093511	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2048/8, ttl=64 (request in 73)
75	89.093841	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2304/9, ttl=255 (reply in 76)
76	89.090821	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2304/9, ttl=64 (request in 75)
79	99.091593	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2560/10, ttl=255 (reply in 80)
80	99.091990	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2560/10, ttl=64 (request in 79)
81	91.094398	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=2816/11, ttl=255 (reply in 82)
82	91.094993	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=2816/11, ttl=64 (request in 81)
83	92.097404	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3072/12, ttl=255 (reply in 84)
84	92.098008	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3072/12, ttl=64 (request in 83)
85	93.090734	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3328/13, ttl=255 (reply in 86)
86	93.091333	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3328/13, ttl=64 (request in 85)
87	94.093700	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3584/14, ttl=255 (reply in 88)
88	94.094268	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3584/14, ttl=64 (request in 87)
89	95.096888	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=3840/15, ttl=255 (reply in 90)
90	95.097458	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=3840/15, ttl=64 (request in 89)
91	96.089900	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb100, seq=4096/16, ttl=255 (reply in 92)
92	96.090524	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb100, seq=4096/16, ttl=64 (request in 91)

Frame 53: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface -, id 0

Ethernet II, Src: 0c:eb:82 (0c:eb:82:e3:00:00), Dst: 0c:eb:82 (0c:eb:82:e3:00:00)

Internet Protocol Version 4, Src: 10.1.2.1, Dst: 10.1.2.2

Internet Control Message Protocol

No.	Time	Source	Destination	Protocol	Length	Info
0000	0c eb 82 e3 00 00 0c 35 dd b2 00 01 00 00 45 00	.....5.....E..				
0010	09 38 bf 17 00 00 ff 01 e4 a9 0a 01 02 01 00 01	.8.....2T.....				
0020	02 02 08 00 32 54 b1 00 00 00 80 ab 0a d6 2c	0.....W.....				
0030	56 55 01 04 83 ab 57 06 87 2e 6f 5e 8d b5 ca ce	VU.....W.....				
0040	eb 42 ec 99 ba 2e	.B.....				

Packets: 182 - Displayed: 34 (18.7%) Profile: Default

Internet Control Message Protocol: Protocol

Packets: 145 - Displayed: 0 (0.0%) Profile: Default

Internet Control Message Protocol: Protocol

- This happened because I didn't configured anything on the Switch side or Web side, so we had an impact only on links that are connect to the router directly. Since my switch is really limited in its configuration (because of version of GNS3 used), let's configure only Web side.
- So, to configure the Web side for link aggregation let's use netplan

- First let's configure bonding interface on the Web using netplan

```

ubuntu@ubuntu-cloud:~$ sudo cat /etc/netplan/50-cloud-init.yaml
network:
  version: 2
  renderer: networkd

  ethernets:
    e0:
      set-name: "e0"
      match:
        macaddress: "0c:eb:82:e3:00:00"
      dhcp4: no
      dhcp6: no

    e1:
      set-name: "e1"
      match:
        macaddress: "0c:eb:82:e3:00:01"
      dhcp4: no
      dhcp6: no

  bonds:
    bond0:
      interfaces:
        - "e0"
        - "e1"
      addresses:
        - 10.1.2.2/24
        - "2001:db8::b/64"
      routes:
        - to: default
          via: 10.1.2.1
        - to: "::/0"
          via: "2001:db8::1"
          on-link: yes
      nameservers:
        addresses:
          - 1.1.1.1
      parameters:
        mode: "balance-rr"
        miimon: 100
        up-delay: 10
        min-links: 1

```

Properties Summary:

- Admin: telnet localhost:5009
- Administration: telnet localhost:5011
- External: none
- HR: telnet localhost:5012
- Internal: none
- Internet: none
- ITDepartment: none
- ITManager: telnet localhost:5006
- Management: telnet localhost:5014
- MikroTikCHR7.16-1: telnet localhost:5005
- Web: telnet localhost:5000

System Information:

- lenovo CPU 14.0%, RAM 68.7%

- So, let's again perform ping from the Router to the Web

```

[admin@mikrotik] > ping 10.1.2.2
PING 10.1.2.2 (10.1.2.2) 56(84) bytes of data.
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=1 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=2 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=3 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=4 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=5 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=6 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=7 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=8 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=9 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=10 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=11 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=12 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=13 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=14 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=15 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=16 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=17 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=18 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=19 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=20 ttl=64 time=0.173 ms
10.1.2.2.1 10.1.2.2.1 56(84) bytes from 10.1.2.2.1: icmp_seq=21 ttl=64 time=0.173 ms
[admin@mikrotik] >

```

- Now it's noticeable that both links transmitted ICMP traffic

- [Web e1 to External Ethernet4]

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icmp

No.	Time	Source	Destination	Protocol	Length	Info
16	31.664372	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=0/0, ttl=255 (no response found!)
17	32.667590	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=256/1, ttl=64
18	33.669247	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=512/2, ttl=255 (no response found!)
19	34.672889	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=768/3, ttl=64
20	35.674483	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=1024/4, ttl=255 (no response found!)
21	36.681876	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=1280/5, ttl=64
22	37.683616	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=1536/6, ttl=255 (no response found!)
23	38.677366	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=1792/7, ttl=64
24	39.679768	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=2048/8, ttl=255 (no response found!)
25	40.683568	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=2304/9, ttl=64
26	41.683398	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=2560/10, ttl=255 (no response found!)
27	42.677689	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=2816/11, ttl=64
28	43.679534	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=3072/12, ttl=255 (no response found!)
29	44.682899	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=3328/13, ttl=64
30	45.685341	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=3584/14, ttl=255 (no response found!)
31	46.691926	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=3840/15, ttl=64
32	47.695066	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=4096/16, ttl=64
33	48.697478	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=4352/17, ttl=255 (no response found!)
34	49.697480	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=4608/18, ttl=64
35	50.693732	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=4864/19, ttl=255 (no response found!)
36	51.694890	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=5120/20, ttl=64
37	52.687427	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=5376/21, ttl=255 (no response found!)

Frame 16: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface -, id 0  
 Ethernet II, Src: 0c:35:dd:b2:00:01 (0c:35:dd:b2:00:01), Dst: 12:37:a5:09:6c:fd (12:37:a5:09:6c:fd)  
 Internet Protocol Version 4, Src: 10.1.2.1, Dst: 10.1.2.2  
 Internet Control Message Protocol

0000 12 37 a5 09 6c fd 0c 35 dd b2 00 01 08 00 45 00 .7 -l -5 .....E:  
 0010 00 38 27 f8 00 00 ff 61 7b c8 0a 01 02 01 0a 01 .B\*.....{ .....,  
 0020 02 02 08 00 2b 54 b8 00 00 00 ab aa d6 2c ..+T- ..,  
 0030 56 55 01 04 83 ab 57 06 87 2e 6f 5e 8d b5 ca ce VU ...W ..o^....,  
 0040 eb 42 ec 99 ba 2e .B ...

Internet Control Message Protocol: Protocol

Packets: 79 · Displayed: 22 (27.8%) Profile: Default

\* [Web e0 to External Ethernet1]

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icmp

No.	Time	Source	Destination	Protocol	Length	Info
17	37.172391	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=0/0, ttl=64
18	38.174245	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=256/1, ttl=255 (no response found!)
19	39.177297	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=512/2, ttl=64
20	40.179648	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=768/3, ttl=255 (no response found!)
21	41.182458	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=1024/4, ttl=64
22	42.185233	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=1280/5, ttl=255 (no response found!)
23	43.191668	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=1536/6, ttl=64
24	44.184123	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=1792/7, ttl=255 (no response found!)
25	45.187792	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=2048/8, ttl=64
26	46.190283	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=2304/9, ttl=255 (no response found!)
27	47.191206	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=2560/10, ttl=64
28	48.187378	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=2816/11, ttl=255 (no response found!)
29	49.187352	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=3072/12, ttl=64
30	50.189589	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=3328/13, ttl=255 (no response found!)
31	51.193339	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=3584/14, ttl=64
32	52.198581	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=3840/15, ttl=255 (no response found!)
33	53.201808	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=4096/16, ttl=255 (no response found!)
34	54.195498	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=4352/17, ttl=64
35	55.197869	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=4608/18, ttl=255 (no response found!)
36	56.201747	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=4864/19, ttl=64
37	57.201612	10.1.2.1	10.1.2.2	ICMP	70	Echo (ping) request id=0xb800, seq=5120/20, ttl=255 (no response found!)
38	58.195364	10.1.2.2	10.1.2.1	ICMP	70	Echo (ping) reply id=0xb800, seq=5376/21, ttl=64

Frame 17: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface -, id 0  
 Ethernet II, Src: 0c:35:dd:b2:00:01 (0c:35:dd:b2:00:01), Dst: 12:37:a5:09:6c:fd (12:37:a5:09:6c:fd)  
 Internet Protocol Version 4, Src: 10.1.2.2, Dst: 10.1.2.1  
 Internet Control Message Protocol

0000 0c 35 dd b2 00 01 12 37 a5 09 6c fd 08 00 45 00 .5 .....7 -l -5 ..E:  
 0010 00 38 f2 ea 00 00 48 01 6f d6 0a 01 02 02 0a 01 .B\*.....{ .....,  
 0020 02 01 00 00 33 54 b8 00 00 00 80 ab aa d6 2c ..+T- ..,  
 0030 56 55 01 04 83 ab 57 06 87 2e 6f 5e 8d b5 ca ce VU ...W ..o^....,  
 0040 eb 42 ec 99 ba 2e .B ...

wireshark\_LNLPX2.pcapng

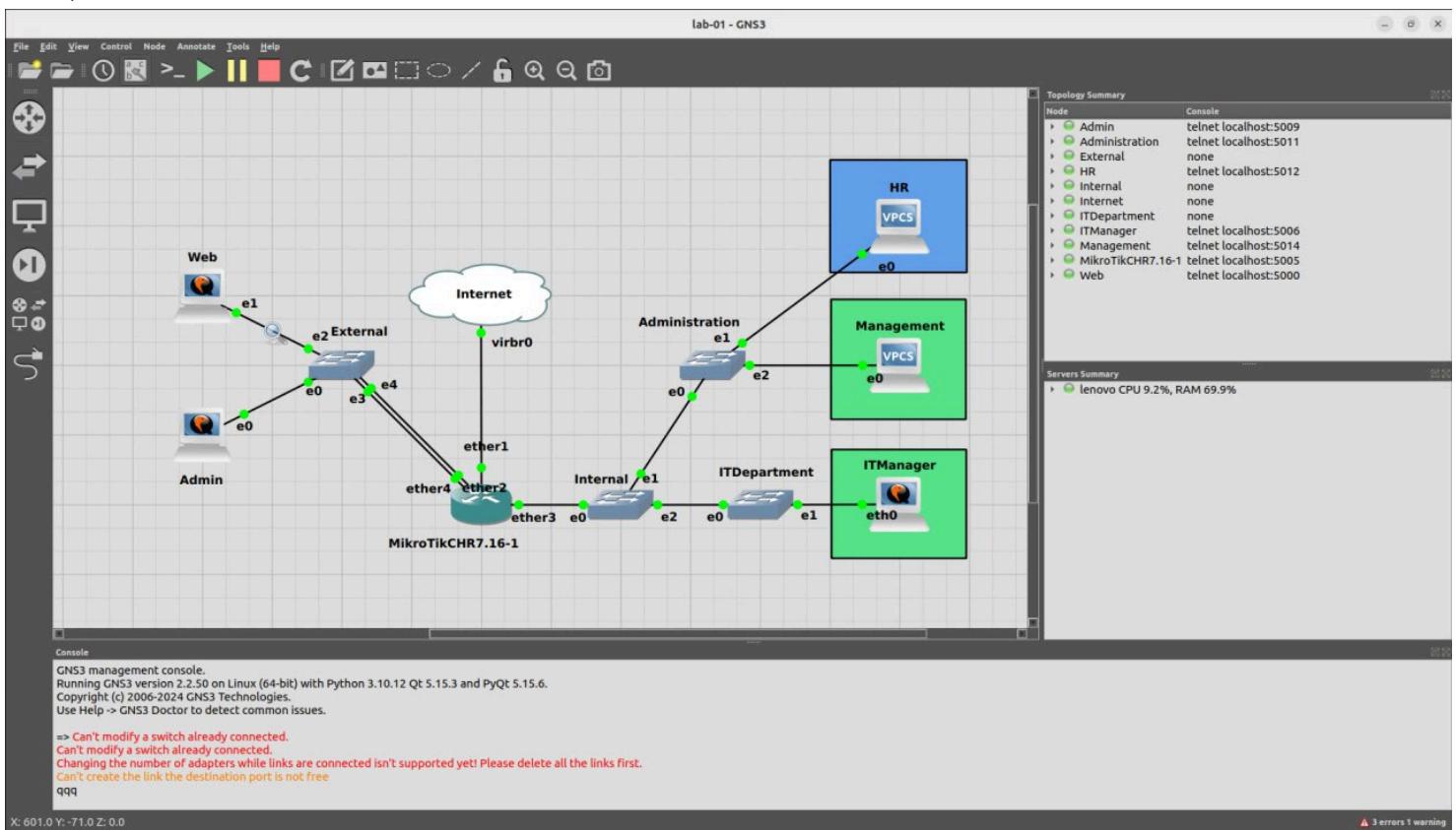
Packets: 76 · Displayed: 22 (28.9%) Profile: Default

- What is interesting here, is that all ICMP requests always go through the same link. Not surprisingly, all replies also always go through the other link.

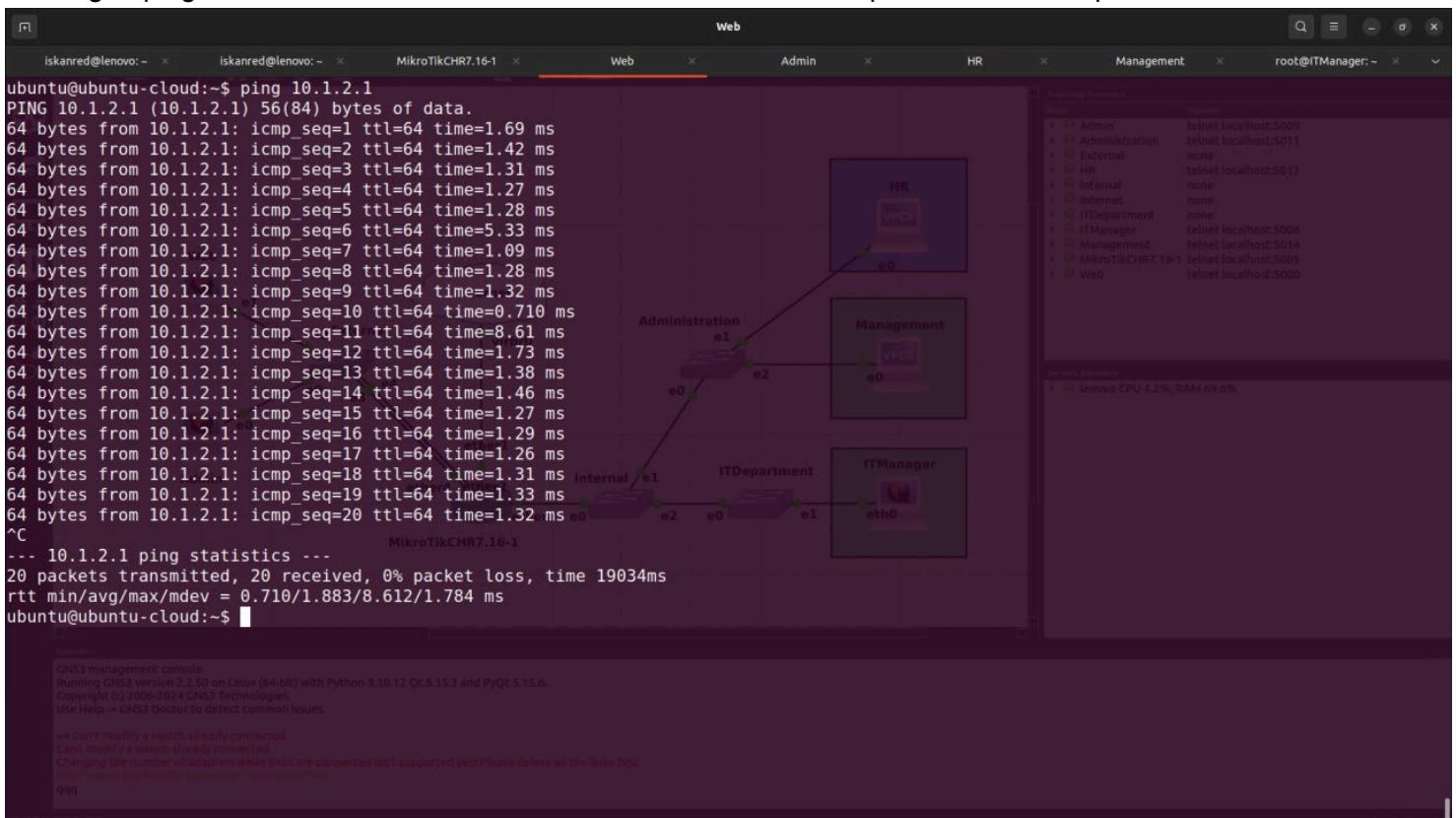
c. Test the Fault Tolerance by stopping one of the cables and see if you have any downtime

- I decided to remove the link from the Web to External. But before it I started pinging from the Web to the Router

- Then, I removed the link

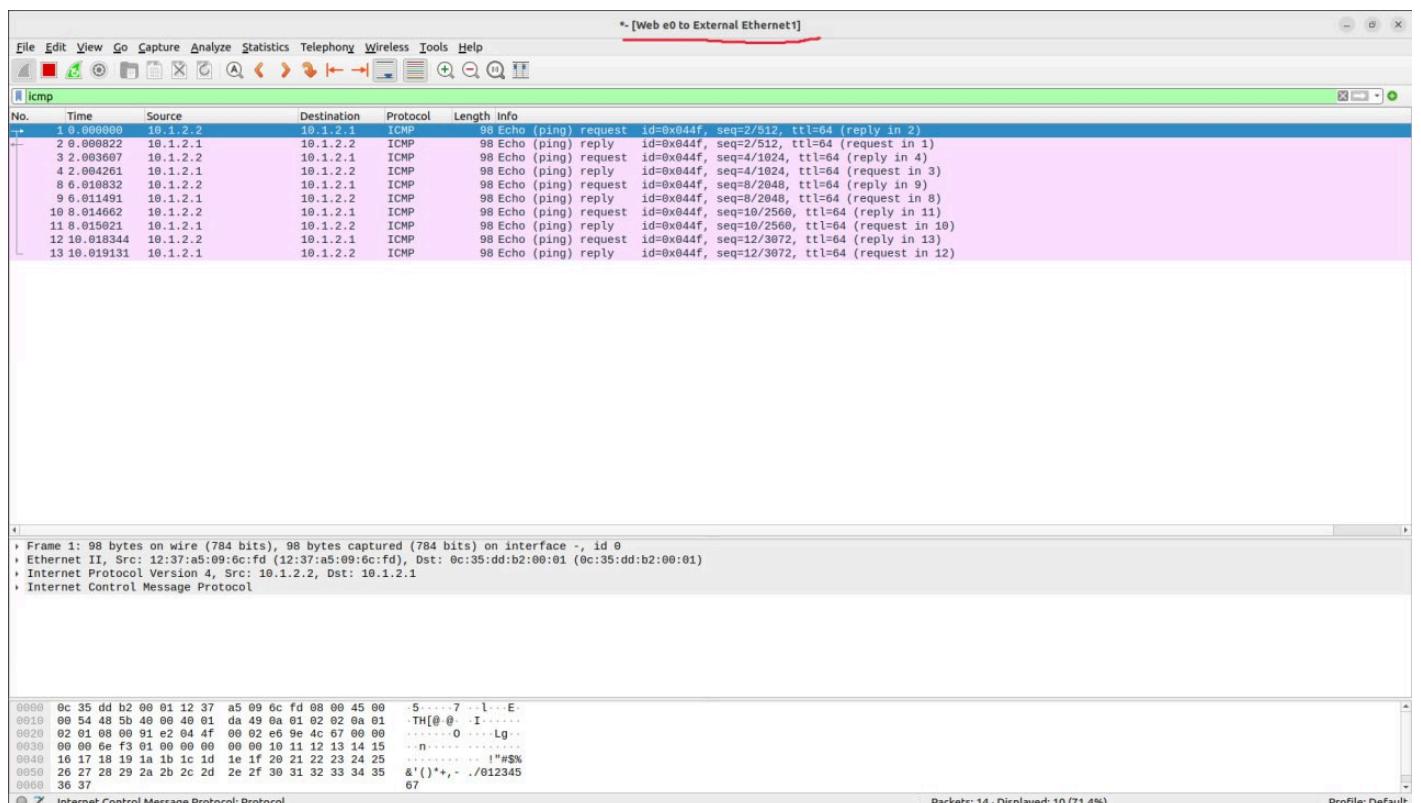


- Looking at ping further we can see there was no downtime at all! 0% packet loss is the proof

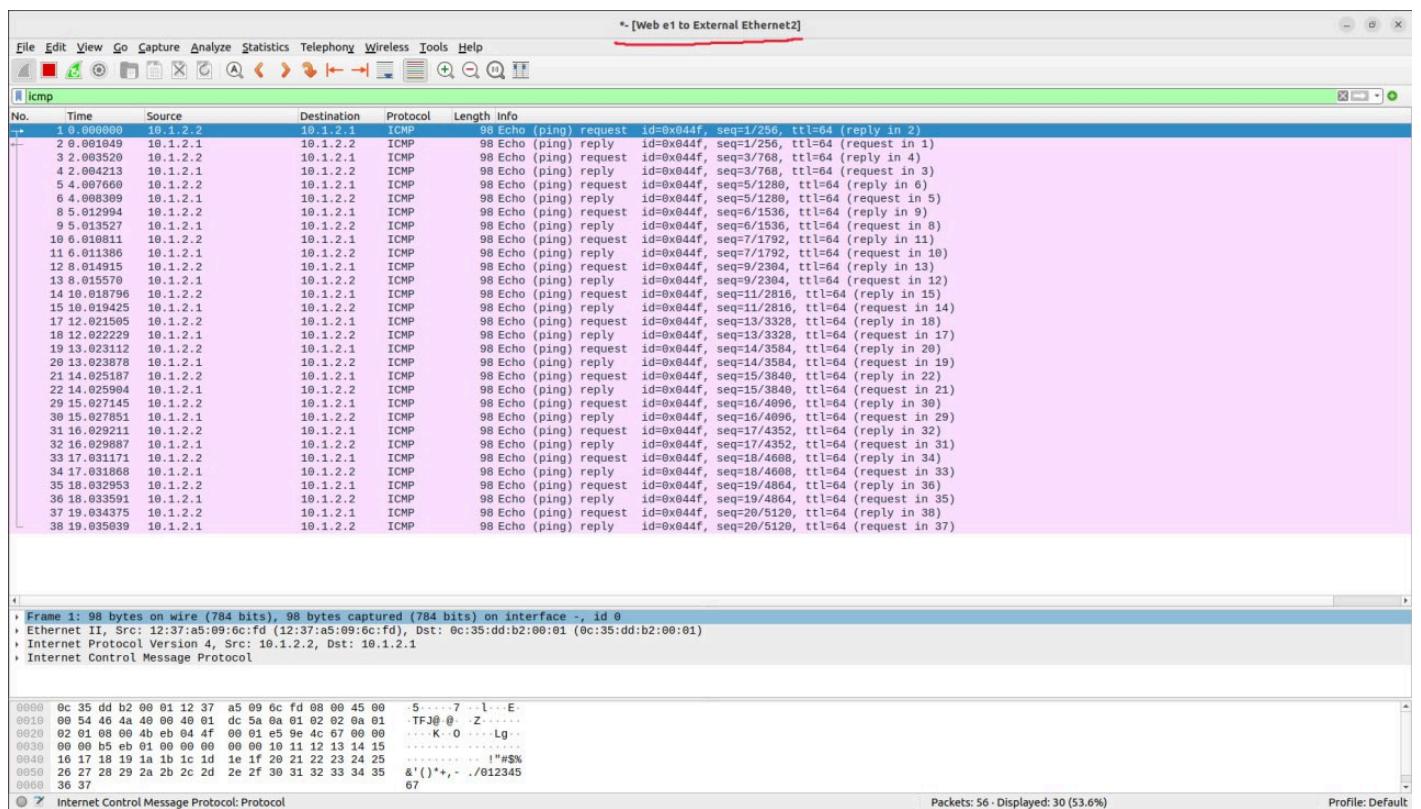


- Let's check Wireshark capturing frames

- Here we can see the link that was removed



- Here is the link that was NOT removed



- Nothing was duplicated and there was no downtime. Probably, such a fast forwarding was caused of using failure detection algorithm that is called **media-independent interface** (MII) which is fast and it depends on the device driver.

## References

- [https://en.wikipedia.org/wiki/IEEE\\_802.1Q](https://en.wikipedia.org/wiki/IEEE_802.1Q)
- <https://en.wikipedia.org/wiki/VLAN>
- [http://xgu.ru/wiki/Native\\_VLAN](http://xgu.ru/wiki/Native_VLAN)
- [https://www.smart-soft.ru/blog/tehnologija\\_vlan/](https://www.smart-soft.ru/blog/tehnologija_vlan/)
- <https://www.auvik.com/franklyit/blog/network-basics-link-aggregation/>