AIM: The purpose of this lab is to understand how Ethernet LANs are managed. Initially the functions of Address Resolution Protocol (ARP) are studied. Followed by which experiments for managing Ethernet switches and configuring virtual LANs spanning multiple switches were conducted. Finally, an experiment to configure Inter-VLAN routing were conducted.

COMPONENTS REQUIRED:

Components	**Quantities**
PC	3
Laptop	1
Switch	1
Hub	1
Access Points	1
Cisco Router	1

EXPERIMENTS:

1. **Initial topology setup**

The following default topology is setup, in which interface eth1 of each PC and interface eth0 of the laptop are connected to the WB-2 switch. The switch is also connected to the lab common network (LNET port).

PC1 – P122 of Work bench patch panel

PC2 – P222 of Work bench patch panel

PC3 – P322 of Work bench patch panel

PC2 – P422 of Work bench patch panel

Lap – LA112 of Work bench patch panel

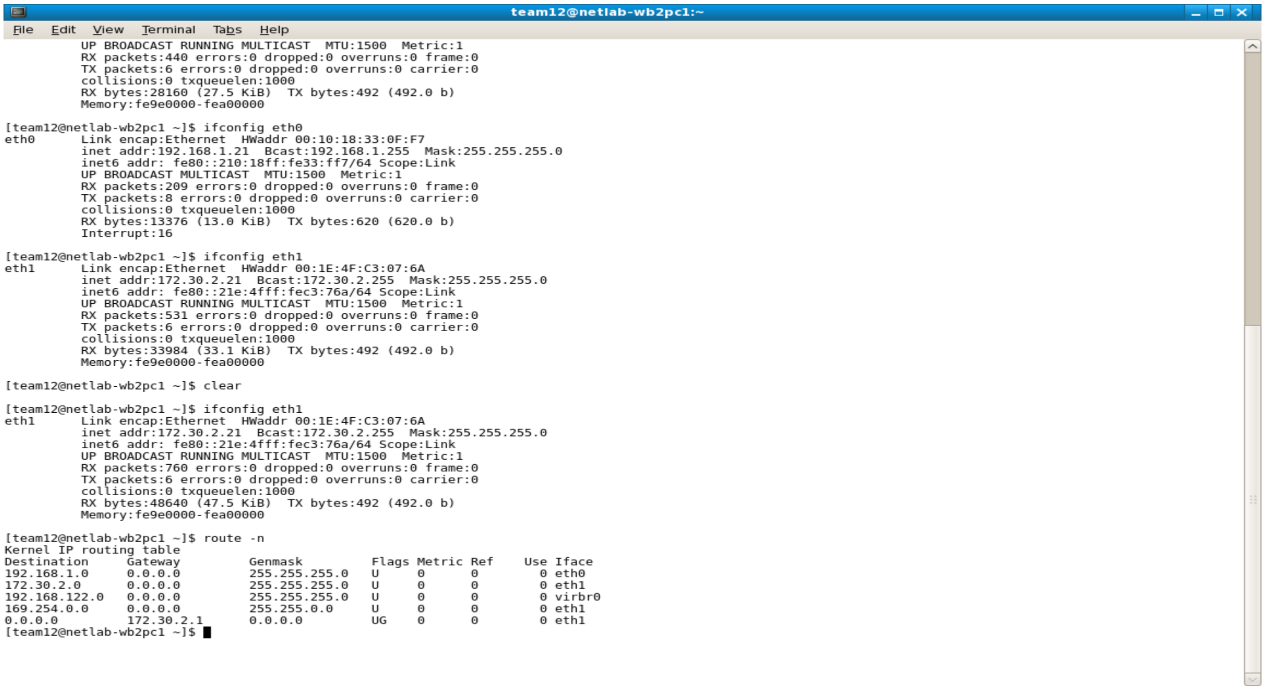
2. **IP addressing and ARP**

The experiment gives an idea on how Address Resolution Protocol (ARP) works and how a host delivers IP packets based on their network parameters configuration.

The IP configuration of every PC is monitored using,

ifconfig eth1 %monitor the IP configuration

route -n %IP routing table is displayed for that PC



```
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:440 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:28160 (27.5 KiB)  TX bytes:492 (492.0 b)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc1 ~]$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:10:18:33:0F:F7
          inet addr:192.168.1.21  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::210:18ff:fe33:ff7/64 Scope:Link
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:209 errors:0 dropped:0 overruns:0 frame:0
          TX packets:8 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:13376 (13.0 KiB)  TX bytes:620 (620.0 b)
          Interrupt:16

[team12@netlab-wb2pc1 ~]$ ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 00:1E:4F:C3:07:6A
          inet addr:172.30.2.21  Bcast:172.30.2.255  Mask:255.255.255.0
          inet6 addr: fe80::21e:4fff:fec3:76a/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:531 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:33984 (33.1 KiB)  TX bytes:492 (492.0 b)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc1 ~]$ clear

[team12@netlab-wb2pc1 ~]$ ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 00:1E:4F:C3:07:6A
          inet addr:172.30.2.21  Bcast:172.30.2.255  Mask:255.255.255.0
          inet6 addr: fe80::21e:4fff:fec3:76a/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:760 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:48640 (47.5 KiB)  TX bytes:492 (492.0 b)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc1 ~]$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.1.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
172.30.2.0      0.0.0.0         255.255.255.0   U     0      0        0 eth1
192.168.122.0   0.0.0.0         255.255.255.0   U     0      0        0 virbr0
169.254.0.0     0.0.0.0         255.255.0.0     U     0      0        0 eth1
0.0.0.0         172.30.2.1      0.0.0.0         UG    0      0        0 eth1
[team12@netlab-wb2pc1 ~]$
```

Fig 1: *PC1 Configuration and Kernel Routing table*

Observations:

The IP routing table for this PC has the destination IP information the corresponding gateway, the general subnet mask, and the Interface to which it is connected,

Route Determination Process

To determine which routing table entry is used for the forwarding decision, IP uses the following process:

For each entry in a routing table, it performs a bit-wise logical AND between the destination IP address and the network mask. The result is compared with the network ID of the entry for a match.

The list of matching routes is compiled. The route that has the longest match (the route that matched the most number of bits with the destination IP address) is chosen. The longest matching route is the most specific route to the destination IP address.

The result of the route determination process is the choice of a single route in the routing table. The route chosen yields a forwarding IP address (the next hop IP address) and an interface (the port). If the route determination process fails to find a route, IP declares a routing error. For a router, an ICMP Destination Unreachable-Host Unreachable message is sent to the source host.

Here, the destination address 172.30.2.21 that is assigned to the Interface eth1 can be contacted directly via the gateway 172.30.2.1. Since, it belongs to the same network. However, the IP 192.168.1.0 that is assigned to the Interface eth1 requires a router to be forwarded to that network.

```
team12@netlab-wb2pc2:~
File Edit View Terminal Tabs Help
[team12@netlab-wb2pc2 ~]$ ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 00:1E:4F:C2:FE:96
          inet addr:172.30.2.22  Bcast:172.30.2.255  Mask:255.255.255.0
          inet6 addr: fe80::21e:4fff:fec2:fe96/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:592 errors:0 dropped:0 overruns:0 frame:0
          TX packets:112 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:37888 (37.0 KiB)  TX bytes:7276 (7.1 KiB)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc2 ~]$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.1.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
172.30.2.0      0.0.0.0         255.255.255.0   U     0      0        0 eth1
192.168.122.0   0.0.0.0         255.255.255.0   U     0      0        0 virbr0
169.254.0.0     0.0.0.0         255.255.0.0     U     0      0        0 eth1
0.0.0.0         172.30.2.1      0.0.0.0         UG    0      0        0 eth1
[team12@netlab-wb2pc2 ~]$
```

Fig 2: *PC2 Configuration and Kernel Routing table*

Observations:

The IP routing table for this PC has the destination IP information the corresponding gateway, the general subnet mask, and the Interface to which it is connected,

Here, the destination address 172.30.2.22 that is assigned to the Interface eth1 can be contacted directly via the gateway 172.30.2.1. Since, it belongs to the same network. However, the IP 192.168.1.0 that is assigned to the Interface eth1 requires a router to be forwarded to that network.

```
team12@netlab-wb2pc3:~
File Edit View Terminal Tabs Help
[team12@netlab-wb2pc3 ~]$ ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 00:1E:4F:C3:00:02
          inet addr:172.30.2.23  Bcast:172.30.2.255  Mask:255.255.255.0
          inet6 addr: fe80::21e:4fff:fec3:2/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:563 errors:0 dropped:0 overruns:0 frame:0
          TX packets:99 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:36032 (35.1 KiB)  TX bytes:6444 (6.2 KiB)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc3 ~]$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.1.0     0.0.0.0         255.255.255.0   U     0      0        0 eth0
172.30.2.0      0.0.0.0         255.255.255.0   U     0      0        0 eth1
169.254.0.0     0.0.0.0         255.255.0.0     U     0      0        0 eth1
0.0.0.0         172.30.2.1      0.0.0.0         UG    0      0        0 eth1
[team12@netlab-wb2pc3 ~]$
```

Fig 3: *PC3 Configuration and Kernel Routing table*

Observations:

The IP routing table for this PC has the destination IP information the corresponding gateway, the general subnet mask, and the Interface to which it is connected, Here, the destination address 172.30.2.23 that is assigned to the Interface eth1 can be contacted directly via the gateway 172.30.2.1. Since, it belongs to the same network. However, the IP 192.168.1.0 that is assigned to the Interface eth1 requires a router to be forwarded to that network.

```
team12@netlab-wb2pc4:~
File  Edit  View  Terminal  Tabs  Help
[team12@netlab-wb2pc4 ~]$ ifconfig eth1
eth1: error fetching interface information: Device not found
[team12@netlab-wb2pc4 ~]$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:1D:09:D4:B3:88
          inet addr:172.30.2.24  Bcast:172.30.2.255  Mask:255.255.255.0
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
          Interrupt:17

[team12@netlab-wb2pc4 ~]$ clear

[team12@netlab-wb2pc4 ~]$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:1D:09:D4:B3:88
          inet addr:172.30.2.24  Bcast:172.30.2.255  Mask:255.255.255.0
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 b)  TX bytes:0 (0.0 b)
          Interrupt:17

[team12@netlab-wb2pc4 ~]$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
172.30.2.0      0.0.0.0         255.255.255.0   U     0      0        0 eth0
192.168.122.0   0.0.0.0         255.255.255.0   U     0      0        0 virbr0
10.246.60.0     0.0.0.0         255.255.254.0   U     0      0        0 wlan0
169.254.0.0     0.0.0.0         255.255.0.0     U     0      0        0 wlan0
0.0.0.0         10.246.60.1     0.0.0.0         UG    0      0        0 wlan0
[team12@netlab-wb2pc4 ~]$
```

Fig 4: *Laptop Configuration and Kernel Routing table*

Observations:

The IP routing table for this PC has the destination IP information the corresponding gateway, the general subnet mask, and the Interface to which it is connected,

Here, the destination address 172.30.2.24 that is assigned to the Interface eth1 can be contacted directly via the gateway 172.30.2.1. Since, it belongs to the same network. However, the IP 192.168.1.0 that is assigned to the Interface eth1 requires a router to be forwarded to that network.

Following this set of analysis, the ARP cache is also verified using the following commands,

arp -n %displays current content of ARP cache

Observation:

If the IP address is not found in the ARP table, the PC will then send a broadcast packet to the network using the ARP protocol to ask "who has 172.30.2.24". Because it is a broadcast packet, it is sent to a special MAC address that causes all machines on the network to receive it.

Before broadcast of those packets, when we learn the arp table there would be no resolution for the IP address instead it shows empty, since no ARP request was generated.

Following the arp cache being empty new arp requests are generated using the following command:

sudo arping [-c N] [-b] -I <interface> <IP address> %generate arp requests

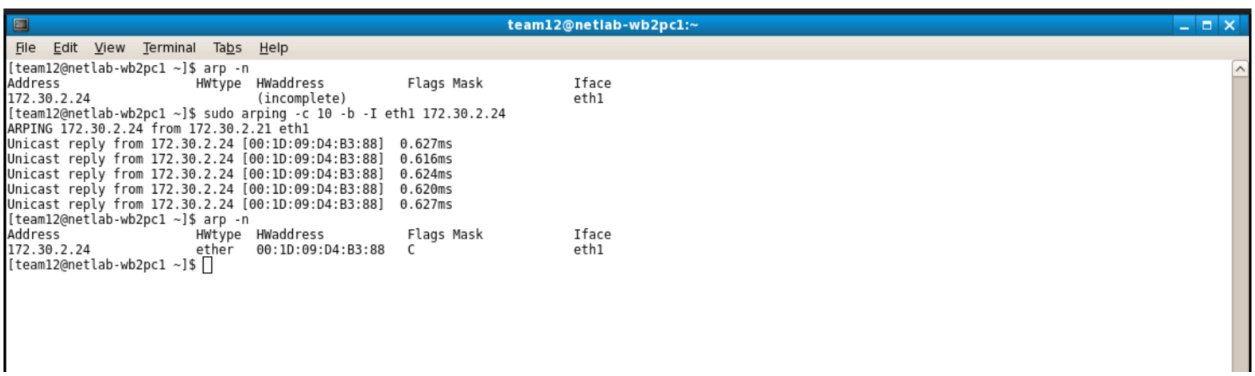
Example:

sudo arping -c 50 -b -I eth0 170.30.2.24.

After the ARP requests gets generated the entry in the arp cache is updated with the corresponding Hardware address as shown in Fig 6.

```
team12@netlab-wb2pc2:~
File Edit View Terminal Tabs Help
[team12@netlab-wb2pc2 ~]$ arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
172.30.2.1                       (incomplete)                              eth1
192.168.1.1                      (incomplete)                              eth0
[team12@netlab-wb2pc2 ~]$ sudo arping -c 50 -b -I eth0 192.168.1.21
Password:
ARPING 192.168.1.21 from 192.168.1.22 eth0
Sent 50 probes (50 broadcast(s))
Received 0 response(s)
[team12@netlab-wb2pc2 ~]$
```

Fig 5: *PC2 arp cache content before arping*



```
team12@netlab-wb2pc1:~
File Edit View Terminal Tabs Help
[team12@netlab-wb2pc1 ~]$ arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
172.30.2.24                      (incomplete)                              eth1
[team12@netlab-wb2pc1 ~]$ sudo arping -c 10 -b -I eth1 172.30.2.24
ARPING 172.30.2.24 from 172.30.2.21 eth1
Unicast reply from 172.30.2.24 [00:1D:09:D4:B3:88]  0.627ms
Unicast reply from 172.30.2.24 [00:1D:09:D4:B3:88]  0.616ms
Unicast reply from 172.30.2.24 [00:1D:09:D4:B3:88]  0.624ms
Unicast reply from 172.30.2.24 [00:1D:09:D4:B3:88]  0.620ms
Unicast reply from 172.30.2.24 [00:1D:09:D4:B3:88]  0.627ms
[team12@netlab-wb2pc1 ~]$ arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
172.30.2.24              ether   00:1D:09:D4:B3:88   C                     eth1
[team12@netlab-wb2pc1 ~]$
```

Fig 6: *PC1 arp cache content before and after arping*

After working with generating arp requests, the ARP packets are captured using the IP packet monitoring tool Wireshark.

In a different PC, the wireshark terminal is opened and the arp request packets are captured within the network and outside the network.

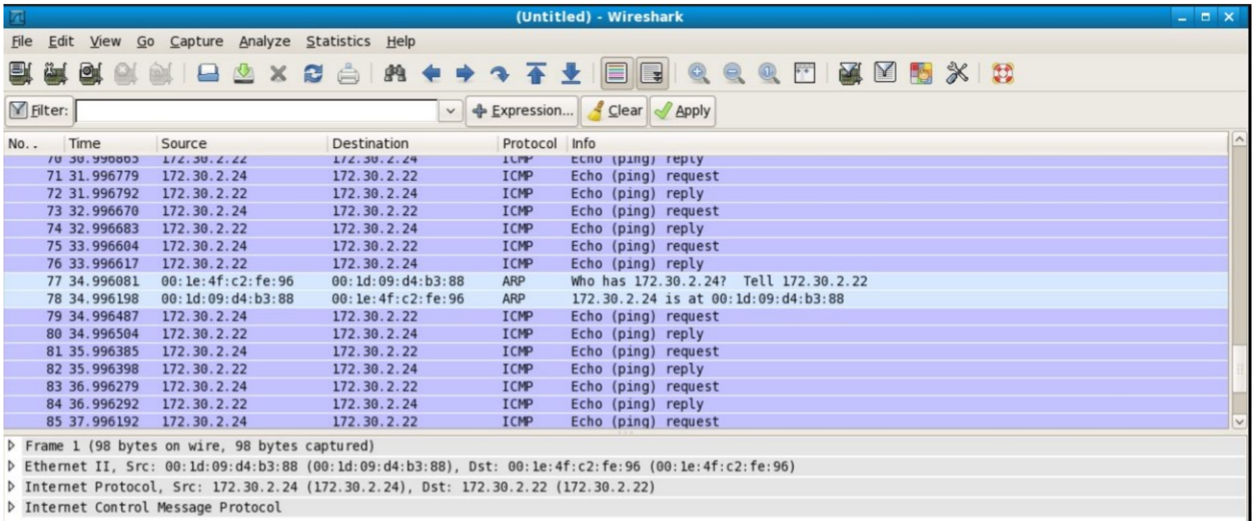


Fig 6: *Wireshark ping capture same network*

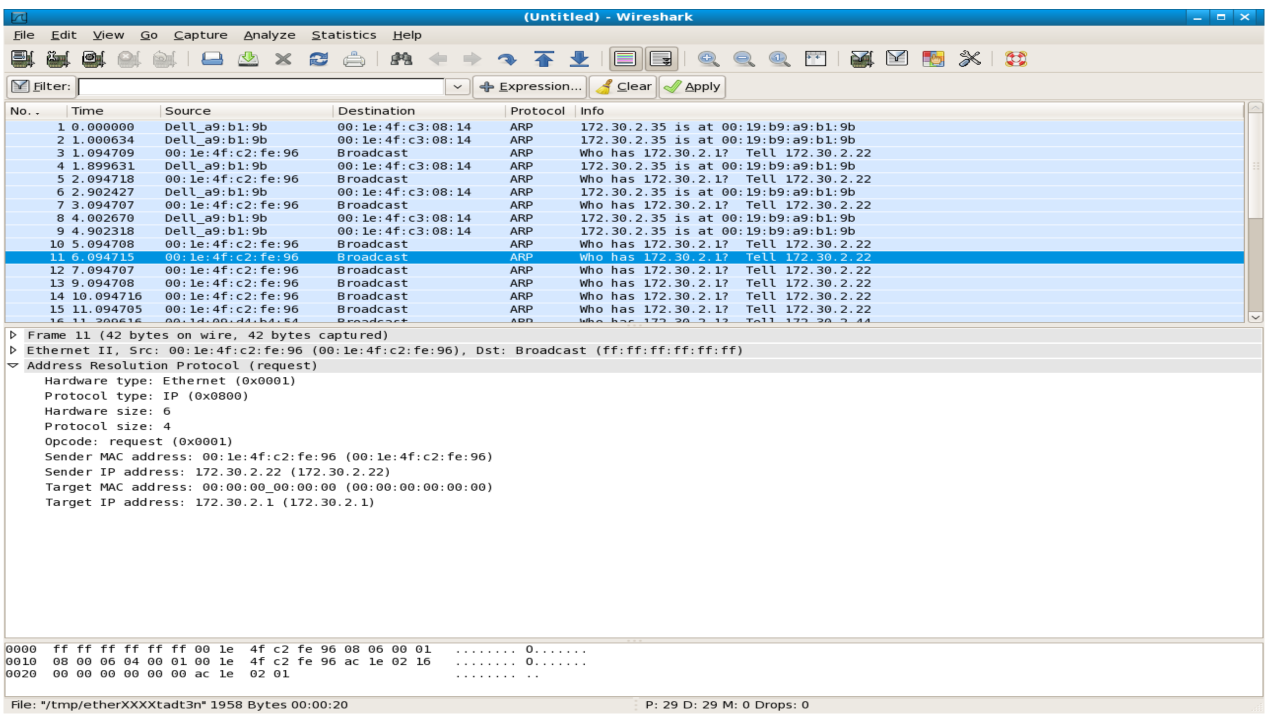


Fig 6: *Wireshark arp capture same network*

Observations:

When the arp packets are generated it is broadcasted to all the PC's connected to the network to find the Hardware Address of that address

In the target, MAC address field the default address is set to 0 in the beginning and then once the Arp cache is updated the MAC ID is updated.

When the ping requests are generated to an external IP address then there exists the error that destination is unreachable and this causes the arp request table to be empty. Since there exists no route to the destined IP address 136.142.116.1

This experiment is followed by creating port based Virtual LAN's for isolating traffic.

A new VLAN is created and few ports are added to these VLAN's, these ports are tagged and then a trunk port is created which is a member to all the VLAN's and the traffic is monitored.

The initial settings for creating, adding ports and tagging of the ports are all done through the management interface of the workbench:

To create VLAN:

VLAN Membership →Create VLAN option→ specify the VLAN ID to be created. (2 & 3)

To add a port to a VLAN:

VLAN Membership →select the desired VLAN ID and click on Apply Changes →check the box corresponding to the port to be assigned to the VLAN →choose U for untagged port (one click) and T for IEEE 802.1Q tagged port (2 clicks)→click on Apply Changes

Then the ports 12 and 14 were added to VLAN2 and the ports 16 and 18 were added to VLAN3 and they are used as untagged ports. Additional port 19 is added to both the VLAN and then it is tagged with the IEEE 802.1Q. This port is used as a trunk port.

To set PVID for a port:

VLAN Port Settings→select the port→set the PVID value → Apply Changes

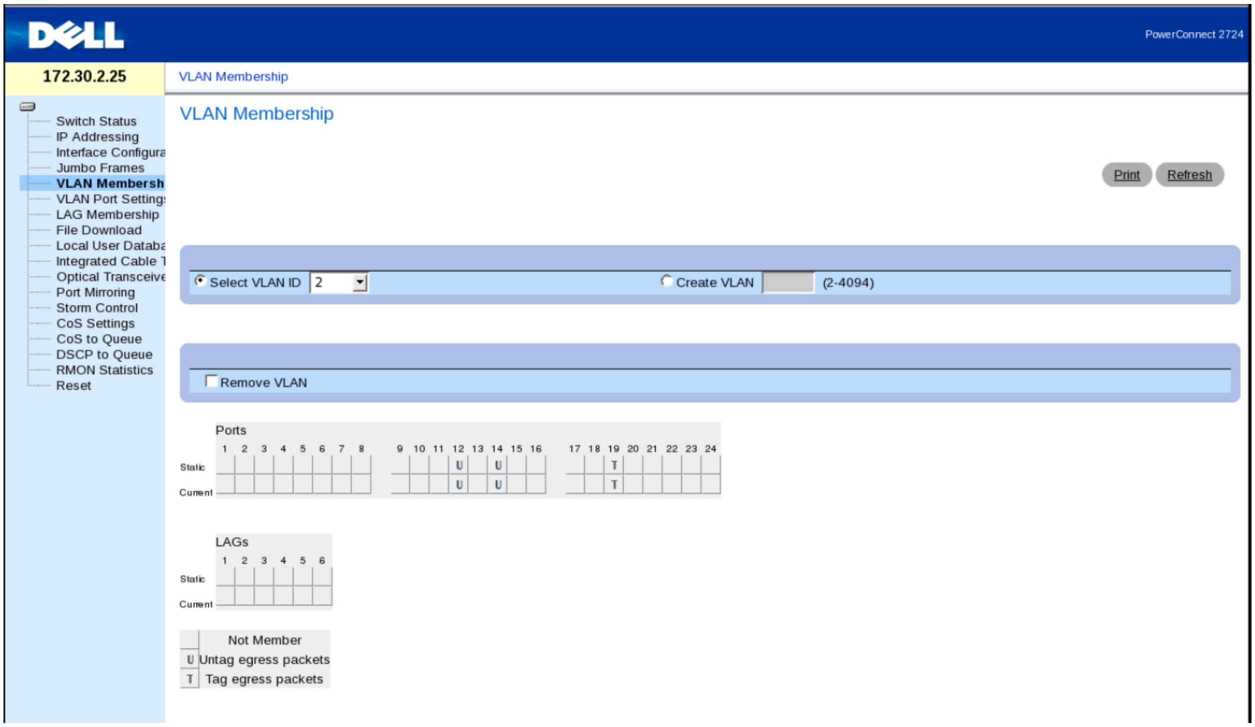


Fig 7: *VLAN 2 Membership*

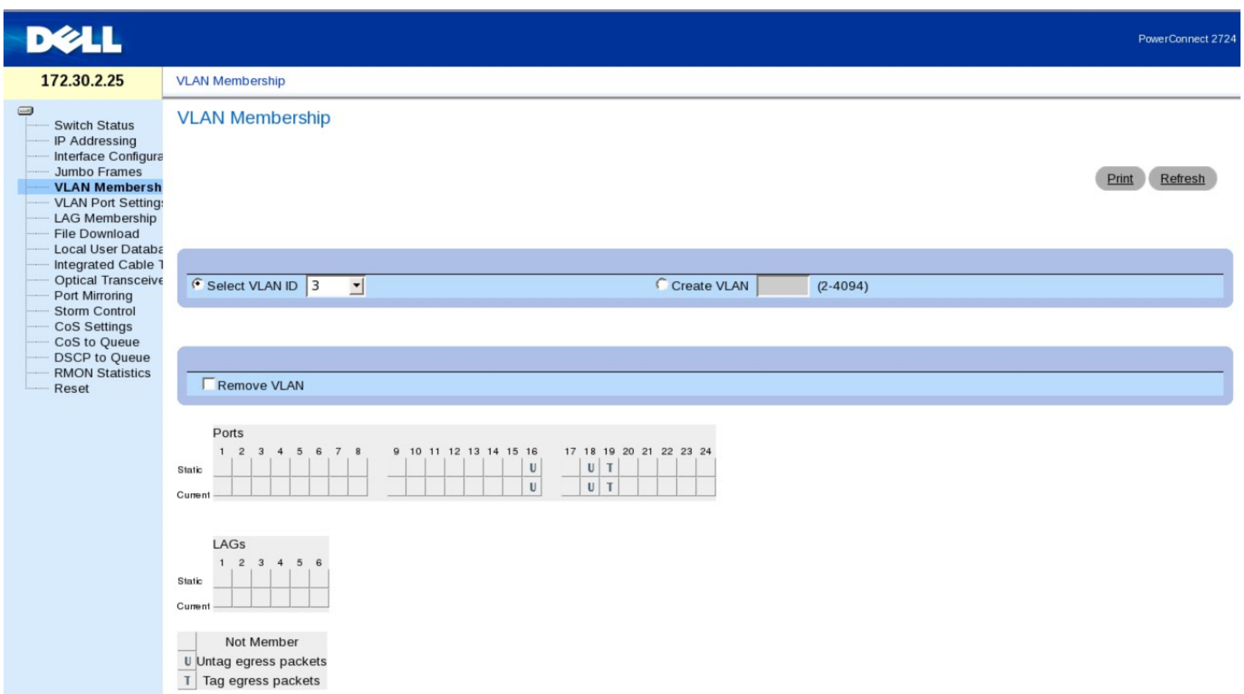
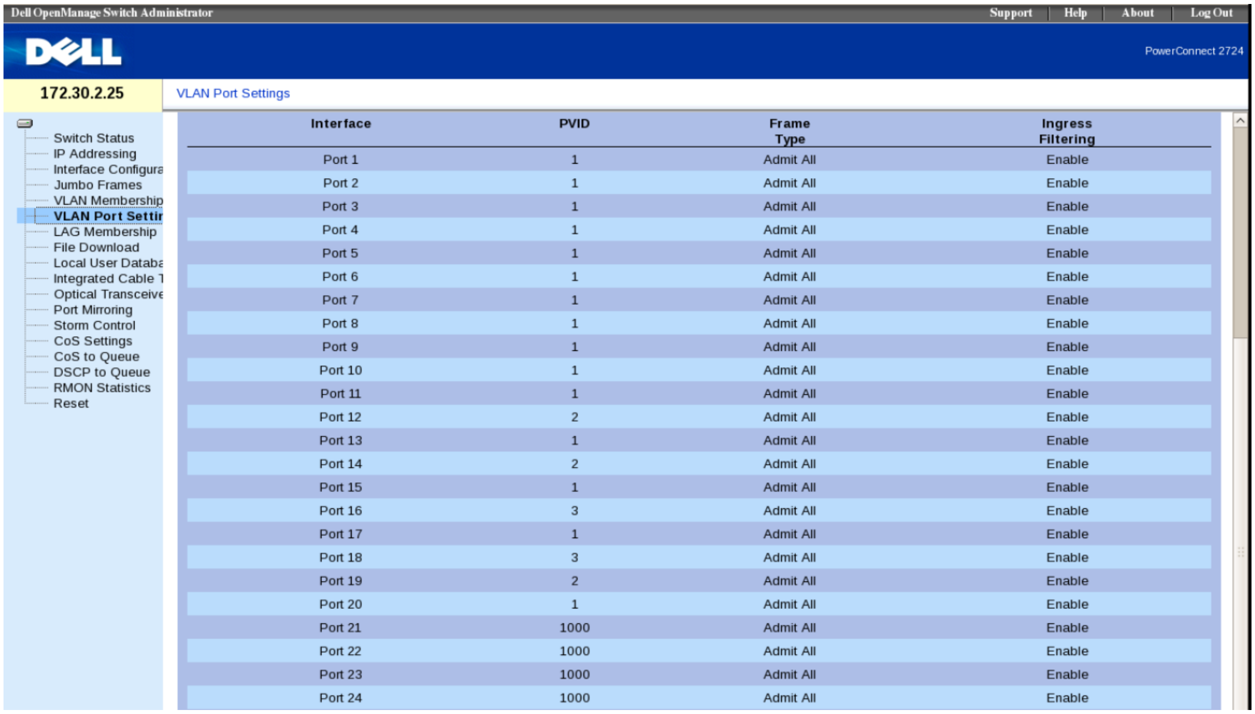


Fig 8: *VLAN 3 Membership*



Interface	PVID	Frame Type	Ingress Filtering
Port 1	1	Admit All	Enable
Port 2	1	Admit All	Enable
Port 3	1	Admit All	Enable
Port 4	1	Admit All	Enable
Port 5	1	Admit All	Enable
Port 6	1	Admit All	Enable
Port 7	1	Admit All	Enable
Port 8	1	Admit All	Enable
Port 9	1	Admit All	Enable
Port 10	1	Admit All	Enable
Port 11	1	Admit All	Enable
Port 12	2	Admit All	Enable
Port 13	1	Admit All	Enable
Port 14	2	Admit All	Enable
Port 15	1	Admit All	Enable
Port 16	3	Admit All	Enable
Port 17	1	Admit All	Enable
Port 18	3	Admit All	Enable
Port 19	2	Admit All	Enable
Port 20	1	Admit All	Enable
Port 21	1000	Admit All	Enable
Port 22	1000	Admit All	Enable
Port 23	1000	Admit All	Enable
Port 24	1000	Admit All	Enable

Fig 9: *VLAN Membership*

interface eth0 of the PC's and laptops are connected to untagged ports as follows:

→PC112 and PC212 to VLAN2

→ PC312 and LA112 to VLAN3

→ The IP address of the laptop NIC is set to 192.168.1.24/24 .

Connectivity of PCs to the laptop is checked over the 192.168.1.0/24 network and the following results were observed.

Observations:

When the ping command was executed the members of VLAN2 could ping among themselves. However, members of different VLAN were not able to ping. Since they belong to different subnets they were not able to ping

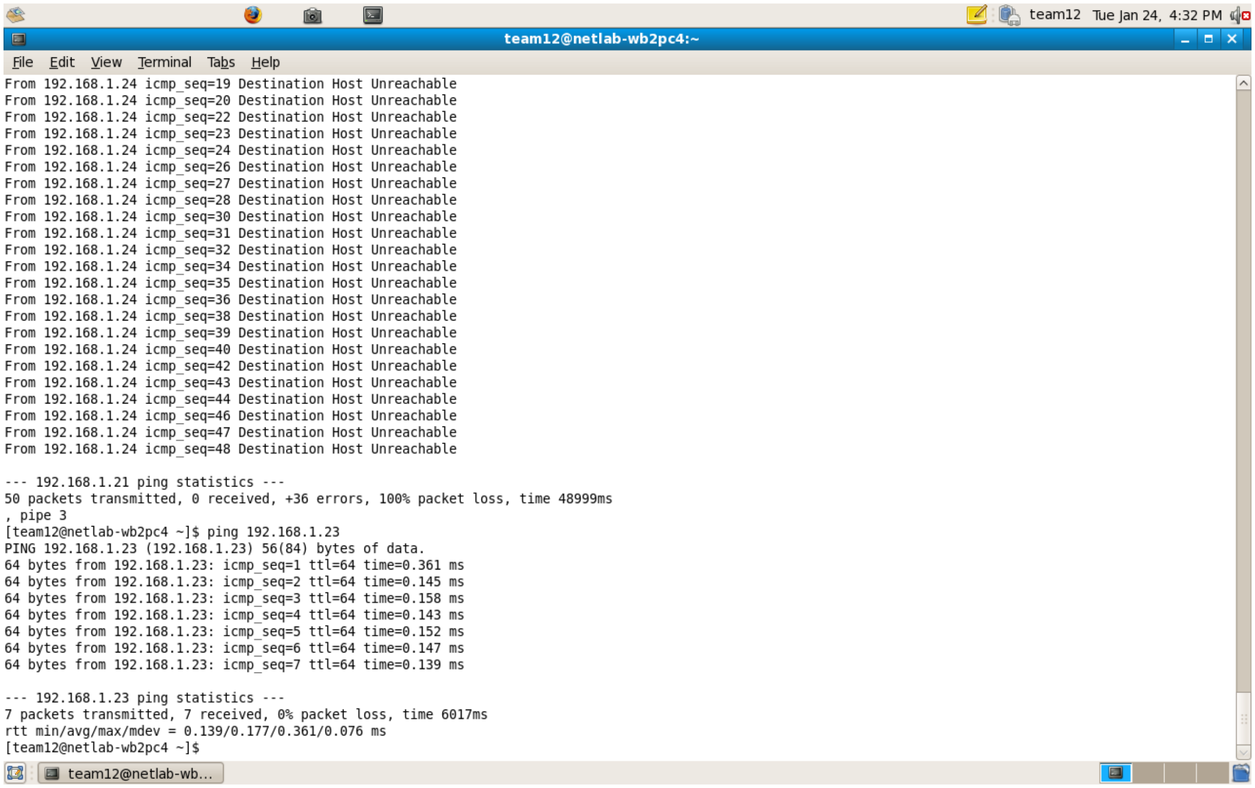


Fig 10: *Ping within VLAN*

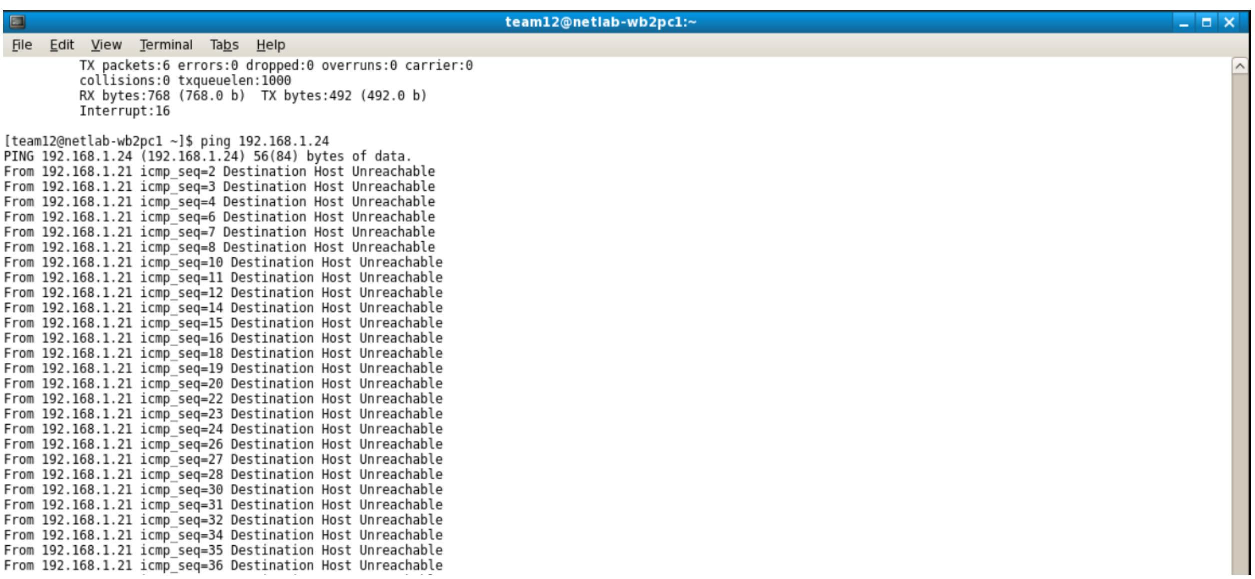


Fig 11: *Ping outside VLAN*

To make VLAN's to work together the trunk configuration is done and then network setup is created as follows

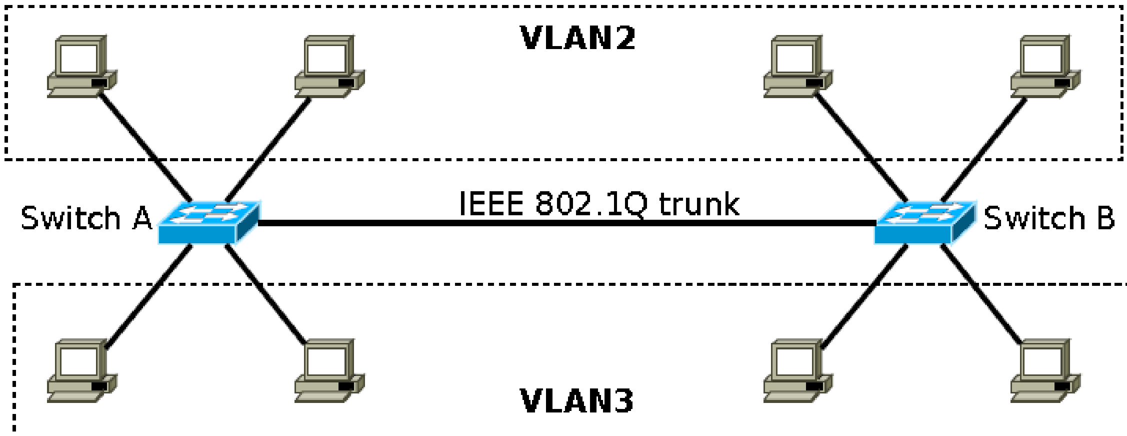


Fig 12: *Connecting switches with trunk port*

Before connecting the two switches, the tagged ports are verified. So temporarily interface eth0 of the PC1 is connected to the tagged port of workbench switch and Wireshark is used to capture packets that are coming out of that port. Broadcast traffic is generated using arping. The following 802.1Q packets are captured and results are reported.

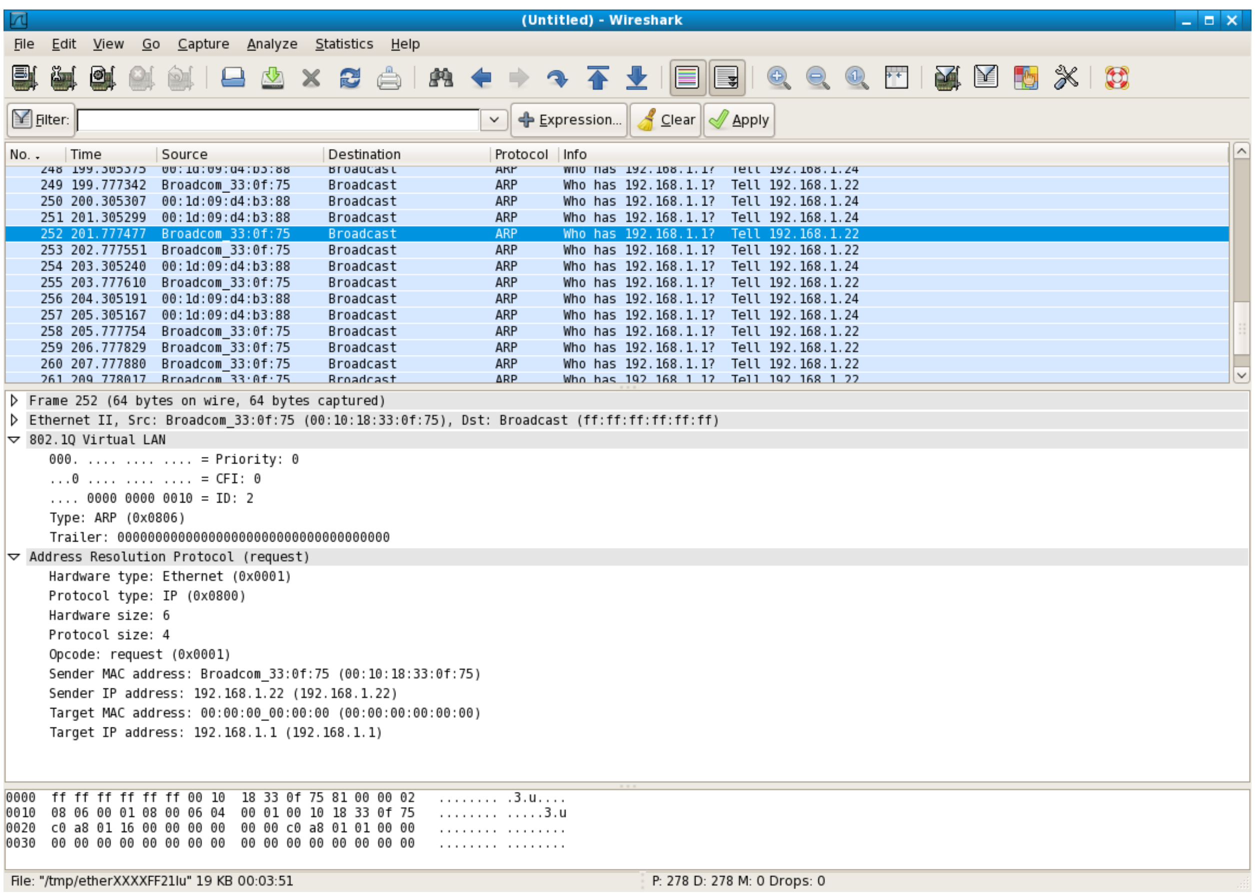


Fig 13: *ARP request VLAN2 packet*

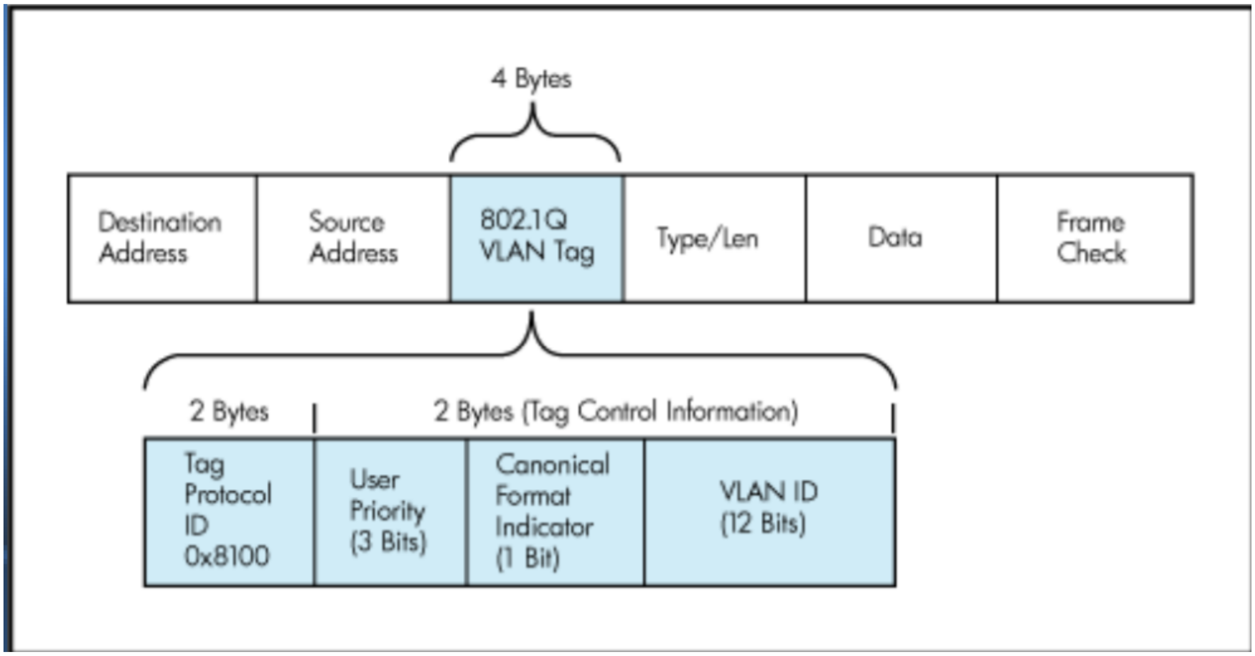


Fig 14: *VLAN packet*

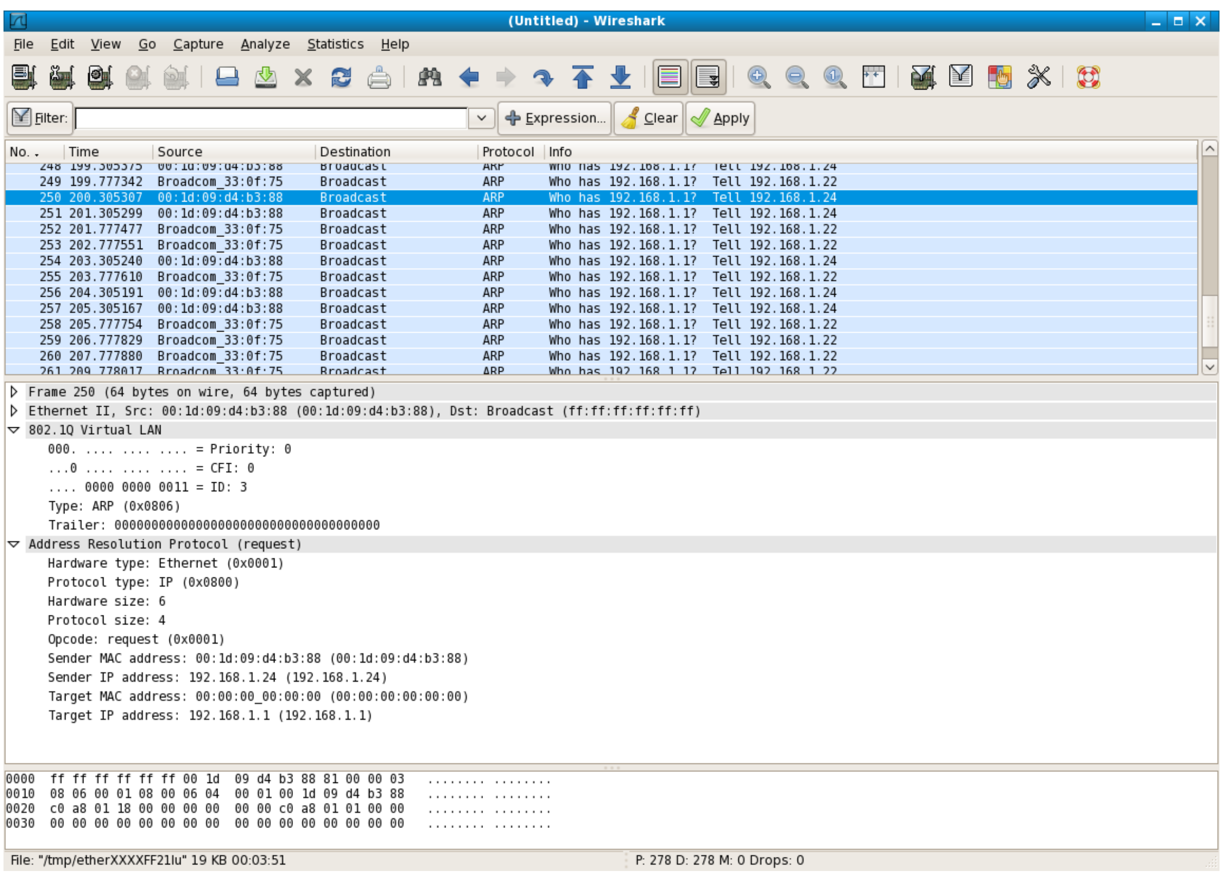
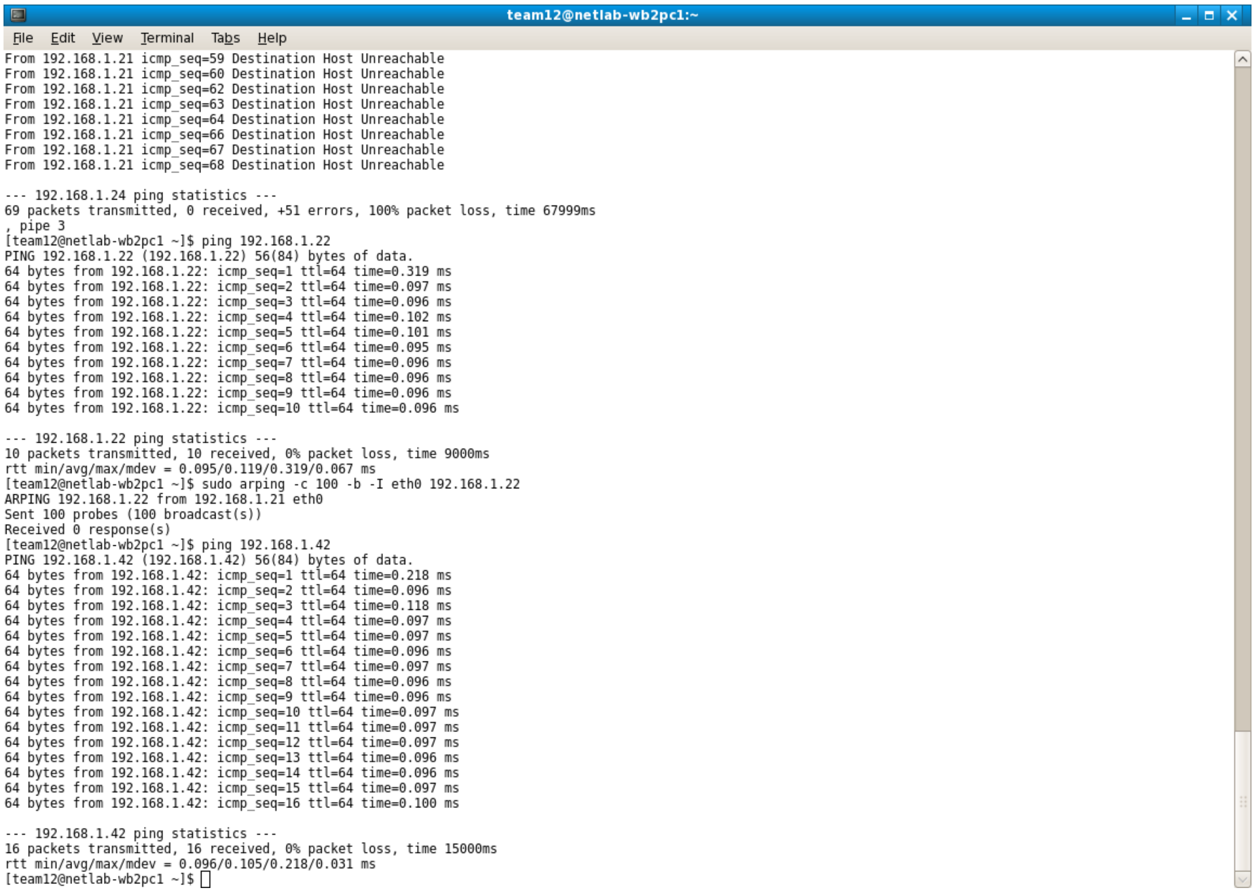


Fig 15: *ARP request VLAN3 packet*

Observations:

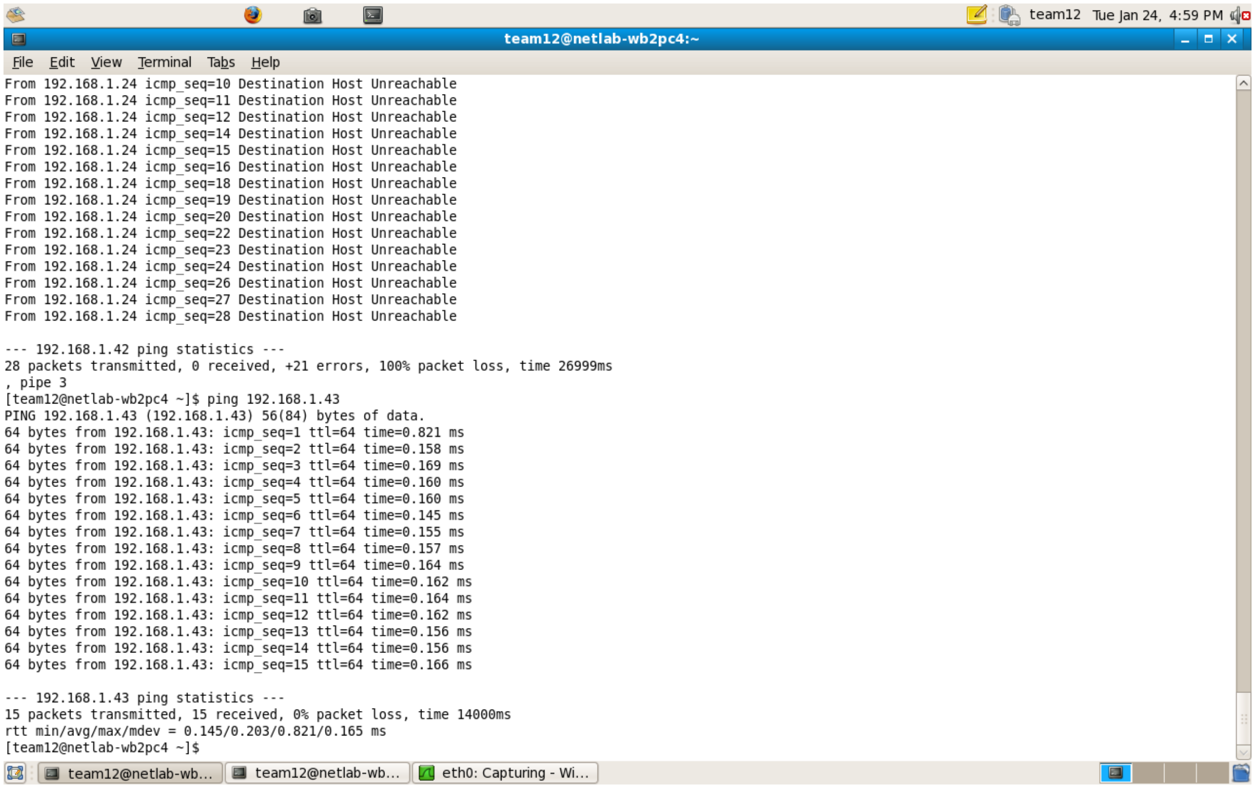
- A networking standard written by the IEEE 802.1 workgroup allowing multiple bridged networks to transparently share the same physical link without leakage of information between networks**.**

802.1Q- Allows multiple VLANs to span multiple switches



```
team12@netlab-wb2pc1:~
File  Edit  View  Terminal  Tabs  Help
From 192.168.1.21 icmp_seq=59 Destination Host Unreachable
From 192.168.1.21 icmp_seq=60 Destination Host Unreachable
From 192.168.1.21 icmp_seq=62 Destination Host Unreachable
From 192.168.1.21 icmp_seq=63 Destination Host Unreachable
From 192.168.1.21 icmp_seq=64 Destination Host Unreachable
From 192.168.1.21 icmp_seq=66 Destination Host Unreachable
From 192.168.1.21 icmp_seq=67 Destination Host Unreachable
From 192.168.1.21 icmp_seq=68 Destination Host Unreachable

--- 192.168.1.24 ping statistics ---
69 packets transmitted, 0 received, +51 errors, 100% packet loss, time 67999ms
, pipe 3
[team12@netlab-wb2pc1 ~]$ ping 192.168.1.22
PING 192.168.1.22 (192.168.1.22) 56(84) bytes of data.
64 bytes from 192.168.1.22: icmp_seq=1 ttl=64 time=0.319 ms
64 bytes from 192.168.1.22: icmp_seq=2 ttl=64 time=0.097 ms
64 bytes from 192.168.1.22: icmp_seq=3 ttl=64 time=0.096 ms
64 bytes from 192.168.1.22: icmp_seq=4 ttl=64 time=0.102 ms
64 bytes from 192.168.1.22: icmp_seq=5 ttl=64 time=0.101 ms
64 bytes from 192.168.1.22: icmp_seq=6 ttl=64 time=0.095 ms
64 bytes from 192.168.1.22: icmp_seq=7 ttl=64 time=0.096 ms
64 bytes from 192.168.1.22: icmp_seq=8 ttl=64 time=0.096 ms
64 bytes from 192.168.1.22: icmp_seq=9 ttl=64 time=0.096 ms
64 bytes from 192.168.1.22: icmp_seq=10 ttl=64 time=0.096 ms

--- 192.168.1.22 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9000ms
rtt min/avg/max/mdev = 0.095/0.119/0.319/0.067 ms
[team12@netlab-wb2pc1 ~]$ sudo arping -c 100 -b -I eth0 192.168.1.22
ARPING 192.168.1.22 from 192.168.1.21 eth0
Sent 100 probes (100 broadcast(s))
Received 0 response(s)
[team12@netlab-wb2pc1 ~]$ ping 192.168.1.42
PING 192.168.1.42 (192.168.1.42) 56(84) bytes of data.
64 bytes from 192.168.1.42: icmp_seq=1 ttl=64 time=0.218 ms
64 bytes from 192.168.1.42: icmp_seq=2 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=3 ttl=64 time=0.118 ms
64 bytes from 192.168.1.42: icmp_seq=4 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=5 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=6 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=7 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=8 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=9 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=10 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=11 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=12 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=13 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=14 ttl=64 time=0.096 ms
64 bytes from 192.168.1.42: icmp_seq=15 ttl=64 time=0.097 ms
64 bytes from 192.168.1.42: icmp_seq=16 ttl=64 time=0.100 ms

--- 192.168.1.42 ping statistics ---
16 packets transmitted, 16 received, 0% packet loss, time 15000ms
rtt min/avg/max/mdev = 0.096/0.105/0.218/0.031 ms
[team12@netlab-wb2pc1 ~]$
```

Fig 16: *Ping same VLAN across workbench*



```
From 192.168.1.24 icmp_seq=10 Destination Host Unreachable
From 192.168.1.24 icmp_seq=11 Destination Host Unreachable
From 192.168.1.24 icmp_seq=12 Destination Host Unreachable
From 192.168.1.24 icmp_seq=14 Destination Host Unreachable
From 192.168.1.24 icmp_seq=15 Destination Host Unreachable
From 192.168.1.24 icmp_seq=16 Destination Host Unreachable
From 192.168.1.24 icmp_seq=18 Destination Host Unreachable
From 192.168.1.24 icmp_seq=19 Destination Host Unreachable
From 192.168.1.24 icmp_seq=20 Destination Host Unreachable
From 192.168.1.24 icmp_seq=22 Destination Host Unreachable
From 192.168.1.24 icmp_seq=23 Destination Host Unreachable
From 192.168.1.24 icmp_seq=24 Destination Host Unreachable
From 192.168.1.24 icmp_seq=26 Destination Host Unreachable
From 192.168.1.24 icmp_seq=27 Destination Host Unreachable
From 192.168.1.24 icmp_seq=28 Destination Host Unreachable

--- 192.168.1.42 ping statistics ---
28 packets transmitted, 0 received, +21 errors, 100% packet loss, time 26999ms
, pipe 3
[team12@netlab-wb2pc4 ~]$ ping 192.168.1.43
PING 192.168.1.43 (192.168.1.43) 56(84) bytes of data.
64 bytes from 192.168.1.43: icmp_seq=1 ttl=64 time=0.821 ms
64 bytes from 192.168.1.43: icmp_seq=2 ttl=64 time=0.158 ms
64 bytes from 192.168.1.43: icmp_seq=3 ttl=64 time=0.169 ms
64 bytes from 192.168.1.43: icmp_seq=4 ttl=64 time=0.160 ms
64 bytes from 192.168.1.43: icmp_seq=5 ttl=64 time=0.160 ms
64 bytes from 192.168.1.43: icmp_seq=6 ttl=64 time=0.145 ms
64 bytes from 192.168.1.43: icmp_seq=7 ttl=64 time=0.155 ms
64 bytes from 192.168.1.43: icmp_seq=8 ttl=64 time=0.157 ms
64 bytes from 192.168.1.43: icmp_seq=9 ttl=64 time=0.164 ms
64 bytes from 192.168.1.43: icmp_seq=10 ttl=64 time=0.162 ms
64 bytes from 192.168.1.43: icmp_seq=11 ttl=64 time=0.164 ms
64 bytes from 192.168.1.43: icmp_seq=12 ttl=64 time=0.162 ms
64 bytes from 192.168.1.43: icmp_seq=13 ttl=64 time=0.156 ms
64 bytes from 192.168.1.43: icmp_seq=14 ttl=64 time=0.156 ms
64 bytes from 192.168.1.43: icmp_seq=15 ttl=64 time=0.166 ms

--- 192.168.1.43 ping statistics ---
15 packets transmitted, 15 received, 0% packet loss, time 14000ms
rtt min/avg/max/mdev = 0.145/0.203/0.821/0.165 ms
[team12@netlab-wb2pc4 ~]$
```

Fig 16: *Ping same VLAN across workbench*

Observation:

When ping is done from same VLAN the two switches can communicate effectively that the tagged port is used for spanning multiple trees.

Simple routing configuration

Aim:

To interconnect two LANs using a router and assign different IP network for the two VLAN for doing a route between them

Components Used:

Components	Quantities
PC	2
Switch	1
Router	1

Network diagram:

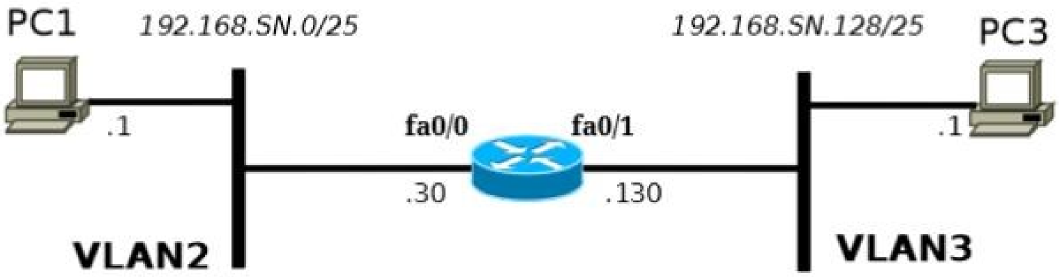
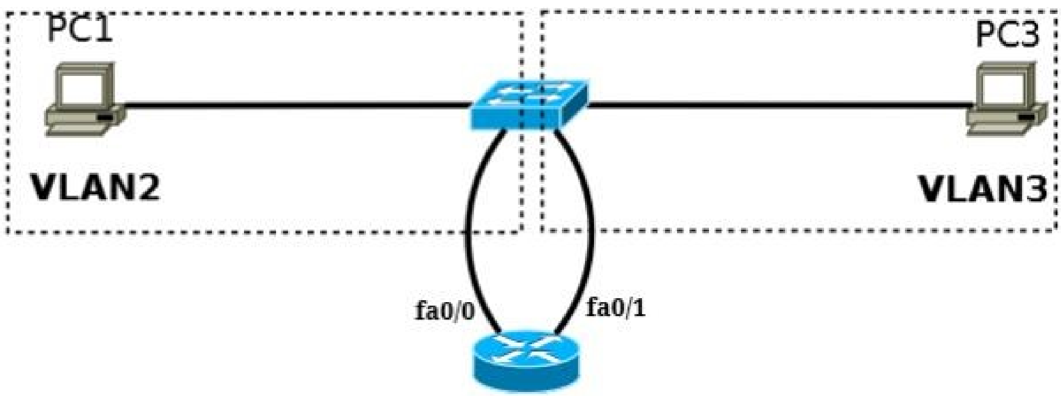


Figure 2: *Logical topology for routing between VLANs*



Setup:

VLAN1 has PC1 and VLAN3 has PC3. A switch is connected between these two PC's and a router is also interconnected

such that fa0/0 and fa0/1 are supported

Process:

ifconfig command is used to configure the IP address of PC1 to 192.168.12.1/25 and PC3 to 192.168.12.129/25 and the two VLAN ports are connected which are available after disconnecting them from the workbench router. Now VLAN2 is in network 192.168.12.0/25 and VLAN3 is in network 192.168.12.128/25 and the router needs to be configured.

The IP addresses to the two router interfaces facing VLAN2 and VLAN3 are 192.168.12.30/25 and 192.168.12.130 respectively. Using some commands, the IP address to these router interfaces are configured which is shown below,

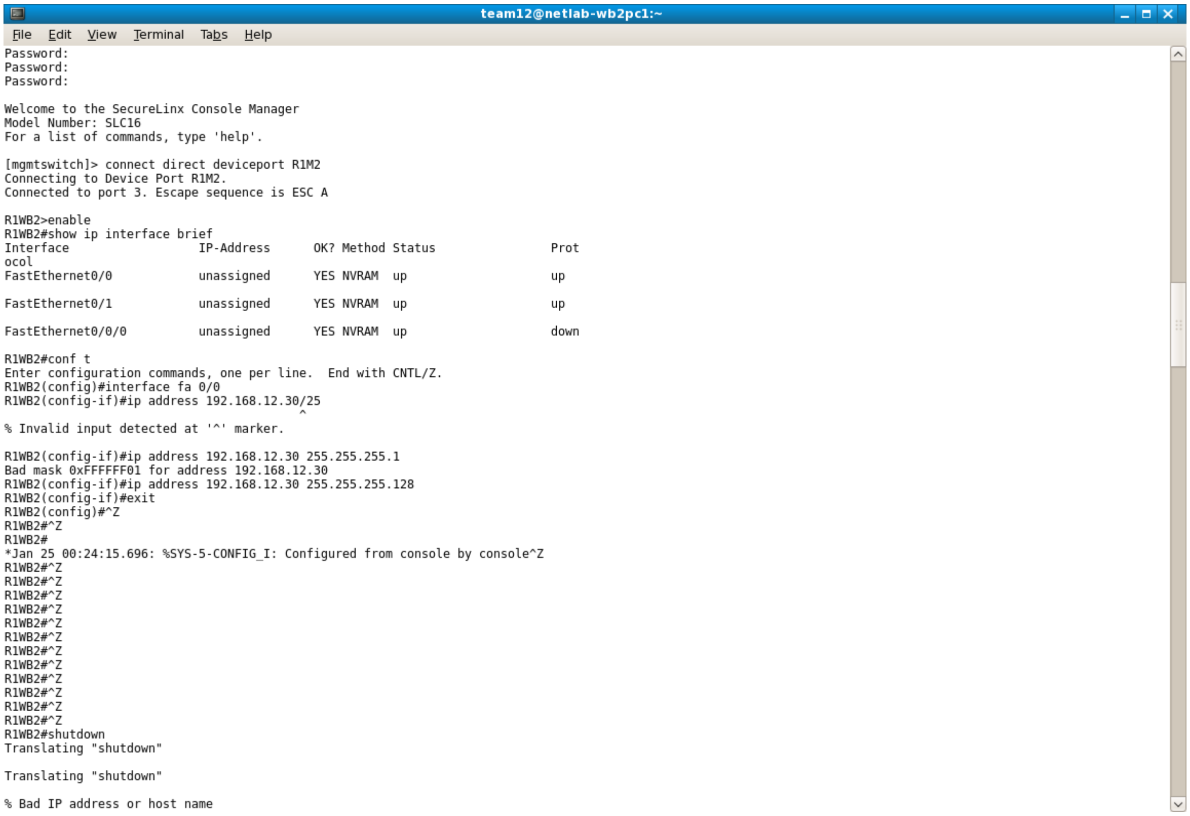
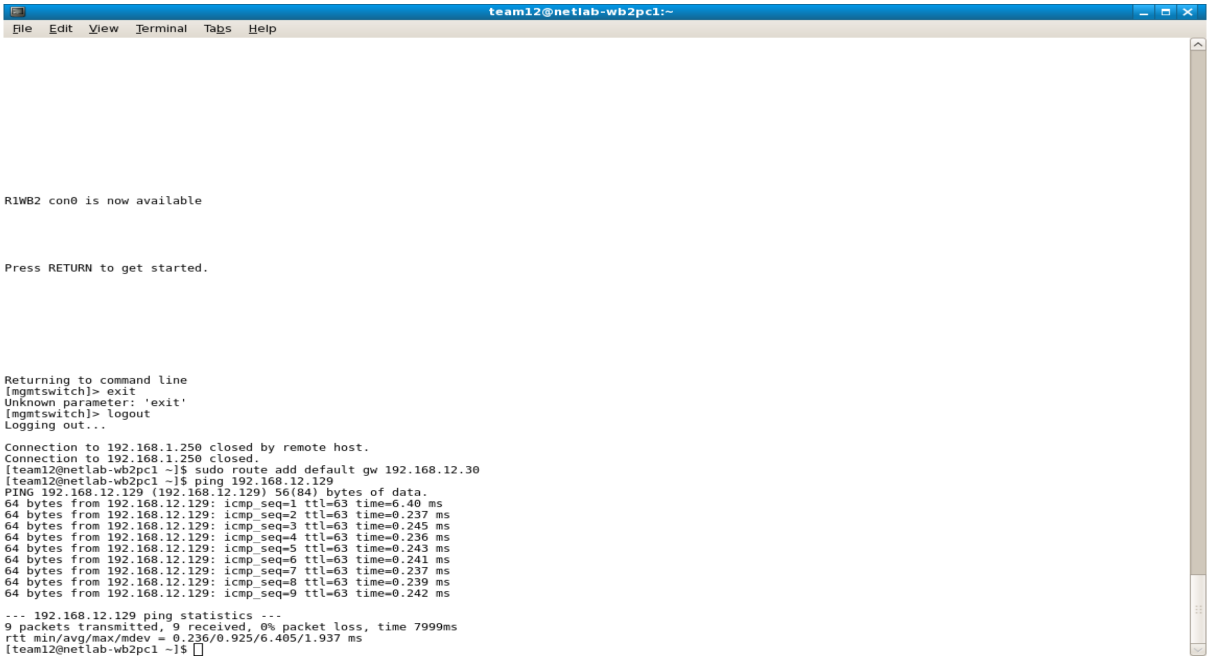


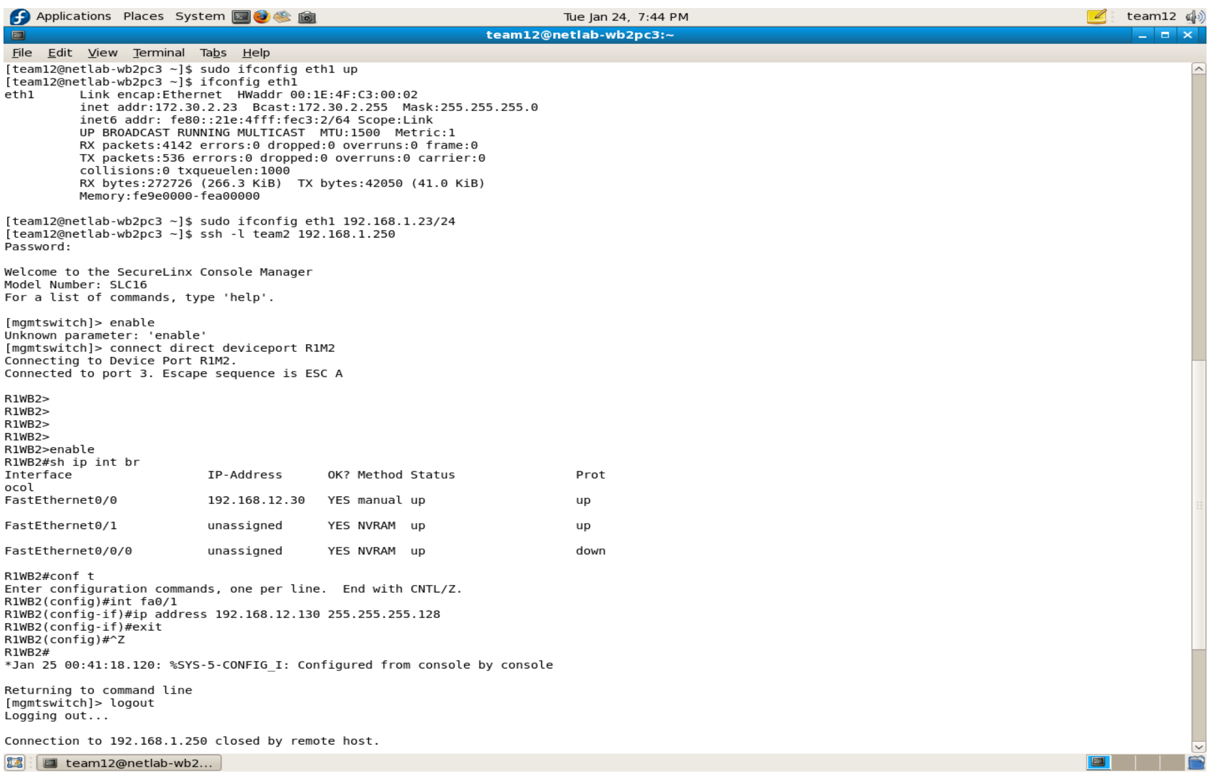
Fig 4.5.1 IP address configuration to router interface using PC1

Once the IP address is assigned, then the command **sudo route add default gw <routerIP>** is executed in both the VLAN



```
R1WB2 con0 is now available



Press RETURN to get started.




Returning to command line
[mgmtswitch]> exit
Unknown parameter: 'exit'
[mgmtswitch]> logout
Logging out...

Connection to 192.168.1.250 closed by remote host.
Connection to 192.168.1.250 closed.
[team12@netlab-wb2pc1 ~]$ sudo route add default gw 192.168.12.30
[team12@netlab-wb2pc1 ~]$ ping 192.168.12.129
PING 192.168.12.129 (192.168.12.129) 56(84) bytes of data.
64 bytes from 192.168.12.129: icmp_seq=1 ttl=63 time=6.40 ms
64 bytes from 192.168.12.129: icmp_seq=2 ttl=63 time=0.237 ms
64 bytes from 192.168.12.129: icmp_seq=3 ttl=63 time=0.245 ms
64 bytes from 192.168.12.129: icmp_seq=4 ttl=63 time=0.236 ms
64 bytes from 192.168.12.129: icmp_seq=5 ttl=63 time=0.243 ms
64 bytes from 192.168.12.129: icmp_seq=6 ttl=63 time=0.241 ms
64 bytes from 192.168.12.129: icmp_seq=7 ttl=63 time=0.237 ms
64 bytes from 192.168.12.129: icmp_seq=8 ttl=63 time=0.239 ms
64 bytes from 192.168.12.129: icmp_seq=9 ttl=63 time=0.242 ms

--- 192.168.12.129 ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 7999ms
rtt min/avg/max/mdev = 0.236/0.925/6.405/1.937 ms
[team12@netlab-wb2pc1 ~]$
```

Fig 4.5.2 IP address configuration to router interface (contd) and pinging to PC3



```
[team12@netlab-wb2pc3 ~]$ sudo ifconfig eth1 up
[team12@netlab-wb2pc3 ~]$ ifconfig eth1
eth1      Link encap:Ethernet  HWaddr 00:1E:4F:C3:00:02
          inet addr:172.30.2.23  Bcast:172.30.2.255  Mask:255.255.255.0
          inet6 addr: fe80::21e:4fff:fec3:2/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:4142 errors:0 dropped:0 overruns:0 frame:0
          TX packets:536 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:272726 (266.3 KiB)  TX bytes:42050 (41.0 KiB)
          Memory:fe9e0000-fea00000

[team12@netlab-wb2pc3 ~]$ sudo ifconfig eth1 192.168.1.23/24
[team12@netlab-wb2pc3 ~]$ ssh -l team2 192.168.1.250
Password:

Welcome to the SecureLinx Console Manager
Model Number: SLC16
For a list of commands, type 'help'.

[mgmtswitch]> enable
Unknown parameter: 'enable'
[mgmtswitch]> connect direct deviceport R1M2
Connecting to Device Port R1M2.
Connected to port 3. Escape sequence is ESC A

R1WB2>
R1WB2>
R1WB2>
R1WB2>
R1WB2>enable
R1WB2#sh ip int br
Interface                  IP-Address      OK? Method Status                Prot
ocol
FastEthernet0/0            192.168.12.30   YES manual up                    up

FastEthernet0/1            unassigned      YES NVRAM  up                    up

FastEthernet0/0/0          unassigned      YES NVRAM  up                    down

R1WB2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1WB2(config)#int fa0/1
R1WB2(config-if)#ip address 192.168.12.130 255.255.255.128
R1WB2(config-if)#exit
R1WB2(config)#^Z
R1WB2#
*Jan 25 00:41:18.120: %SYS-5-CONFIG_I: Configured from console by console

Returning to command line
[mgmtswitch]> logout
Logging out...

Connection to 192.168.1.250 closed by remote host.
```

Fig 4.5.3 IP address configuration to router interface using PC3

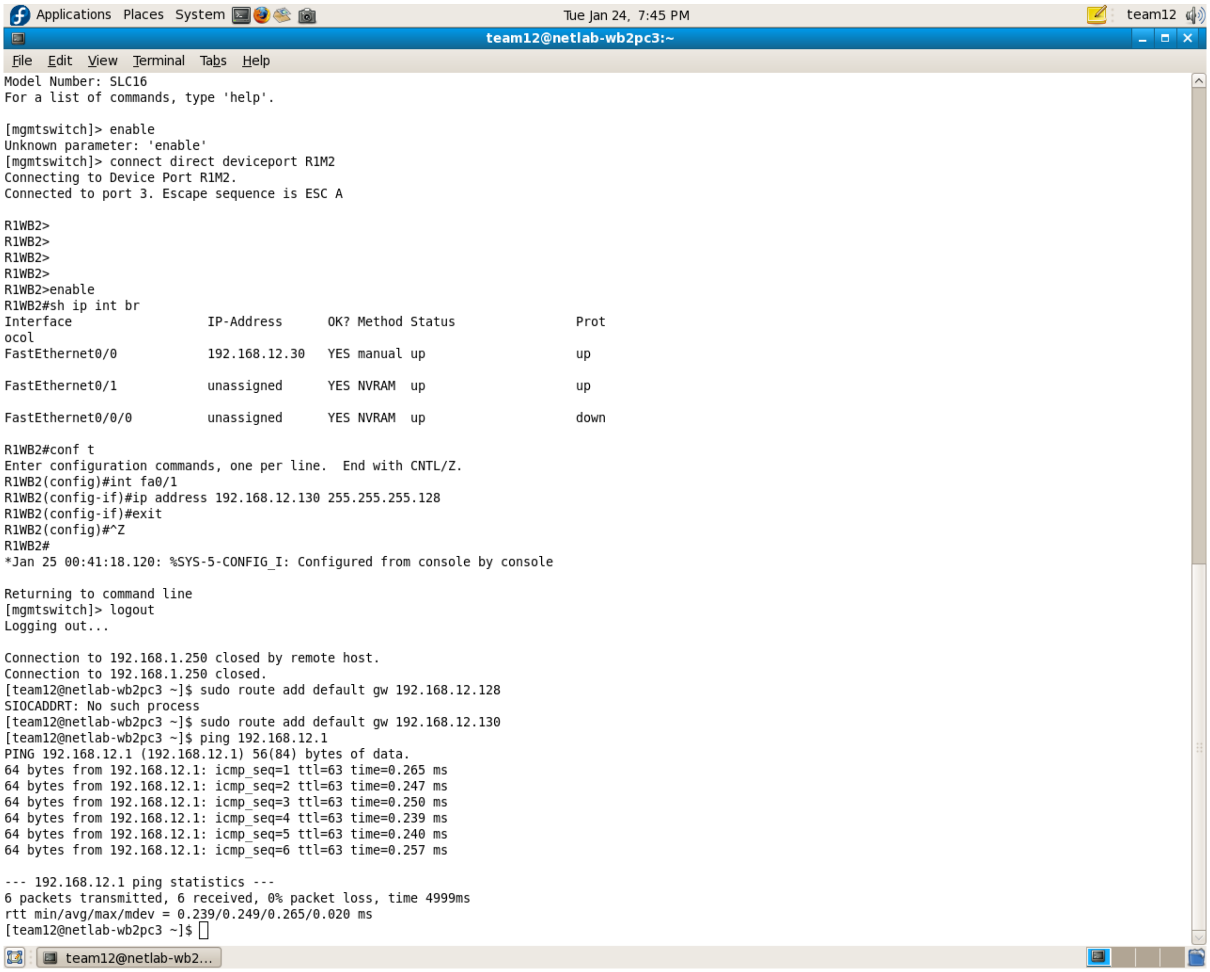


Fig 4.5.4 IP address configuration to router interface (contd) and pinging to PC1

Ping function and trace route command is performed between both PC's

Inter-VLAN routing configuration

Aim:

To configure a scalable solution for inter-VLAN routing by using a single router interface and a single switch port to interconnect multiple VLAN

Components Used:

Components	Quantities
PC	2
Switch	1
Router	1

Setup:

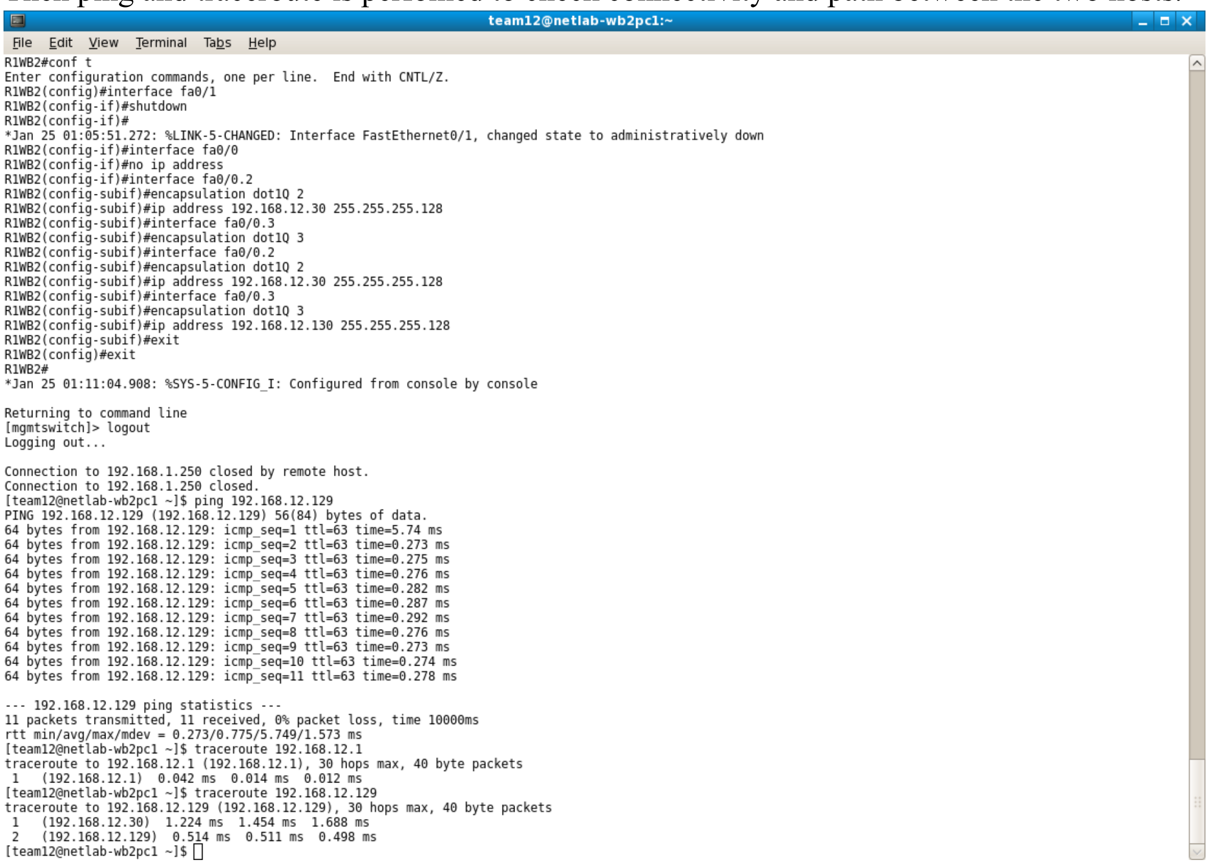
The tagged port is connected to interface fa0/0 of the router and the interface fa0/1 is disconnected.

Process:

Interface fa0/1 is shut down using the command interface **fa0/1 shut down** and the IP address of fa0/0 is removed using **interface fa0/0 no ip address .** Then the following commands are executed to create two sub interfaces for two VLANs and for assigning IP address.

interface fa0/0.2
Encapsulation dot 1Q 2
ip address 192.168.12.30 255.255.255.128
interface fa0/0.3
Encapsulation dot 1Q 3
ip address 192.168.12.130 255.255.255.128

Then ping and traceroute is perfomed to check connectivity and path between the two hosts.




```
R1WB2#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1WB2(config)#interface fa0/1
R1WB2(config-if)#shutdown
R1WB2(config-if)#
*Jan 25 01:05:51.272: %LINK-5-CHANGED: Interface FastEthernet0/1, changed state to administratively down
R1WB2(config-if)#interface fa0/0
R1WB2(config-if)#no ip address
R1WB2(config-if)#interface fa0/0.2
R1WB2(config-subif)#encapsulation dot1Q 2
R1WB2(config-subif)#ip address 192.168.12.30 255.255.255.128
R1WB2(config-subif)#interface fa0/0.3
R1WB2(config-subif)#encapsulation dot1Q 3
R1WB2(config-subif)#interface fa0/0.2
R1WB2(config-subif)#encapsulation dot1Q 2
R1WB2(config-subif)#ip address 192.168.12.30 255.255.255.128
R1WB2(config-subif)#interface fa0/0.3
R1WB2(config-subif)#encapsulation dot1Q 3
R1WB2(config-subif)#ip address 192.168.12.130 255.255.255.128
R1WB2(config-subif)#exit
R1WB2(config)#exit
R1WB2#
*Jan 25 01:11:04.908: %SYS-5-CONFIG_I: Configured from console by console

Returning to command line
[mgmtswitch]> logout
Logging out...

Connection to 192.168.1.250 closed by remote host.
Connection to 192.168.1.250 closed.
[team12@netlab-wb2pc1 ~]$ ping 192.168.12.129
PING 192.168.12.129 (192.168.12.129) 56(84) bytes of data.
64 bytes from 192.168.12.129: icmp_seq=1 ttl=63 time=5.74 ms
64 bytes from 192.168.12.129: icmp_seq=2 ttl=63 time=0.273 ms
64 bytes from 192.168.12.129: icmp_seq=3 ttl=63 time=0.275 ms
64 bytes from 192.168.12.129: icmp_seq=4 ttl=63 time=0.276 ms
64 bytes from 192.168.12.129: icmp_seq=5 ttl=63 time=0.282 ms
64 bytes from 192.168.12.129: icmp_seq=6 ttl=63 time=0.287 ms
64 bytes from 192.168.12.129: icmp_seq=7 ttl=63 time=0.292 ms
64 bytes from 192.168.12.129: icmp_seq=8 ttl=63 time=0.276 ms
64 bytes from 192.168.12.129: icmp_seq=9 ttl=63 time=0.273 ms
64 bytes from 192.168.12.129: icmp_seq=10 ttl=63 time=0.274 ms
64 bytes from 192.168.12.129: icmp_seq=11 ttl=63 time=0.278 ms

--- 192.168.12.129 ping statistics ---
11 packets transmitted, 11 received, 0% packet loss, time 10000ms
rtt min/avg/max/mdev = 0.273/0.775/5.749/1.573 ms
[team12@netlab-wb2pc1 ~]$ traceroute 192.168.12.1
traceroute to 192.168.12.1 (192.168.12.1), 30 hops max, 40 byte packets
 1   (192.168.12.1)  0.042 ms  0.014 ms  0.012 ms
[team12@netlab-wb2pc1 ~]$ traceroute 192.168.12.129
traceroute to 192.168.12.129 (192.168.12.129), 30 hops max, 40 byte packets
 1   (192.168.12.30)  1.224 ms  1.454 ms  1.688 ms
 2   (192.168.12.129)  0.514 ms  0.511 ms  0.498 ms
[team12@netlab-wb2pc1 ~]$
```

Fig 4.6.1 Ping & trace route from PC1

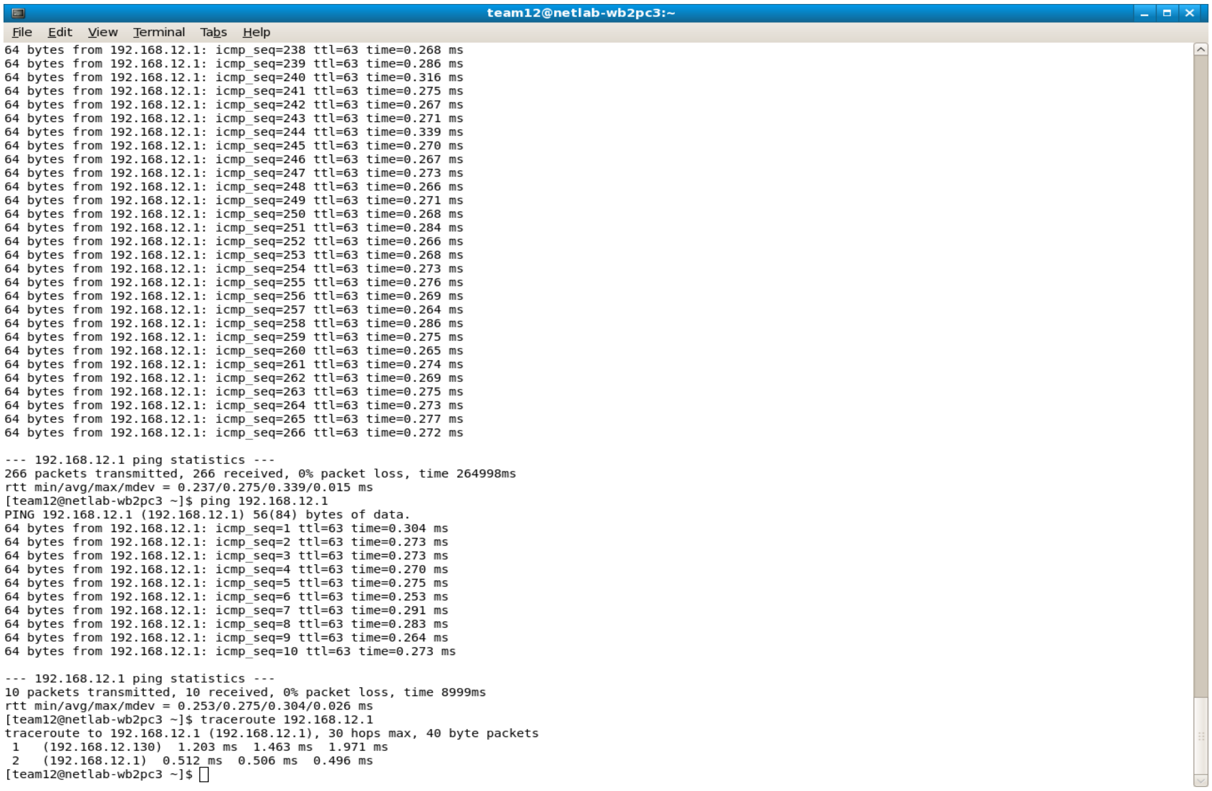
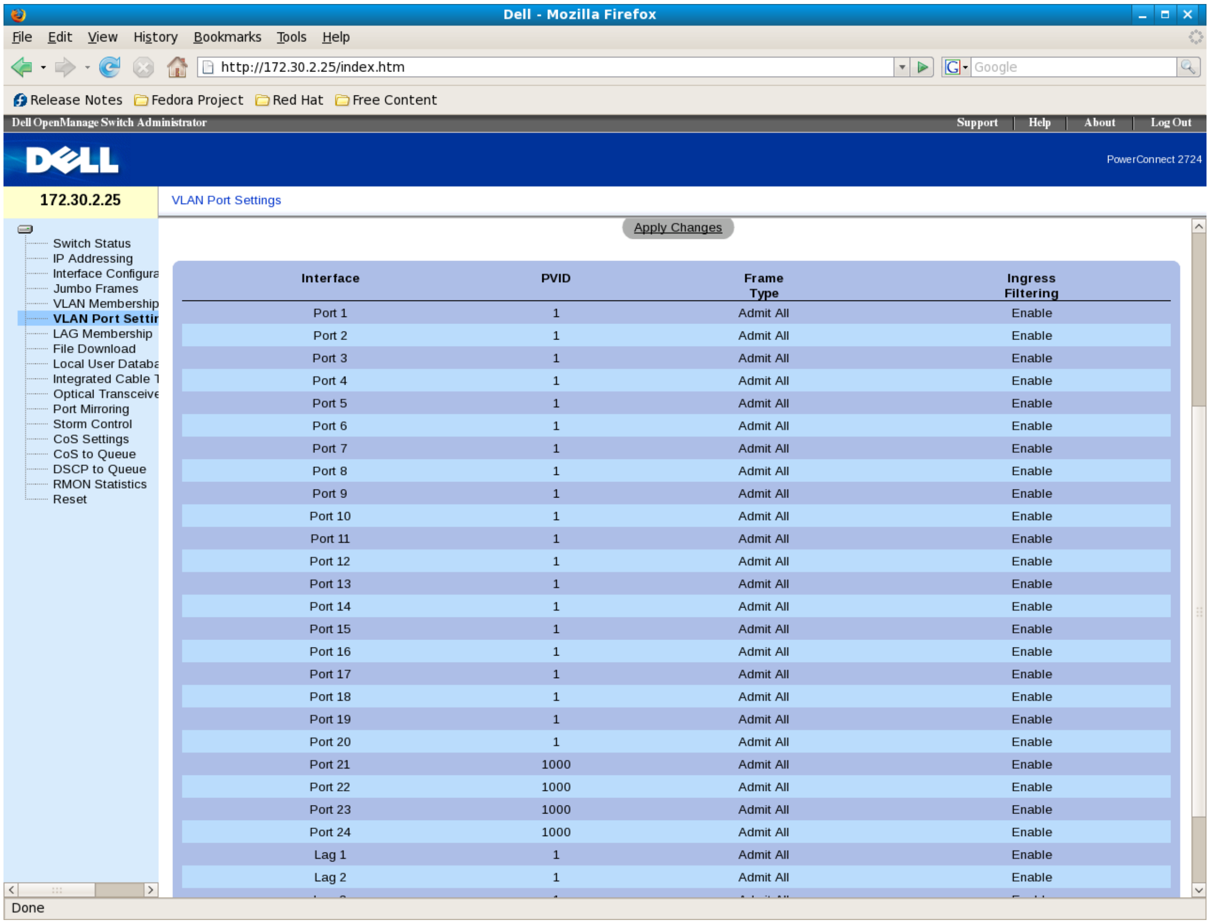


Fig 4.6.2 Ping & trace route from PC3

Then the original switch configuration is done by removing VLAN2 and VLAN3. Even the original VPID is restored as shown below,



Interface	PVID	Frame Type	Ingress Filtering
Port 1	1	Admit All	Enable
Port 2	1	Admit All	Enable
Port 3	1	Admit All	Enable
Port 4	1	Admit All	Enable
Port 5	1	Admit All	Enable
Port 6	1	Admit All	Enable
Port 7	1	Admit All	Enable
Port 8	1	Admit All	Enable
Port 9	1	Admit All	Enable
Port 10	1	Admit All	Enable
Port 11	1	Admit All	Enable
Port 12	1	Admit All	Enable
Port 13	1	Admit All	Enable
Port 14	1	Admit All	Enable
Port 15	1	Admit All	Enable
Port 16	1	Admit All	Enable
Port 17	1	Admit All	Enable
Port 18	1	Admit All	Enable
Port 19	1	Admit All	Enable
Port 20	1	Admit All	Enable
Port 21	1000	Admit All	Enable
Port 22	1000	Admit All	Enable
Port 23	1000	Admit All	Enable
Port 24	1000	Admit All	Enable
Lag 1	1	Admit All	Enable
Lag 2	1	Admit All	Enable

Fig 4.6.3 Restored PVID