

**Design of Networks and Communication Systems Assignment – TRACK D**  
**University of Trento – A.Y 2015 - 2016**



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## **TECHNICAL REPORT**

### **OBJECTIVE:**

- ◆ The Objective of the Project is to design and Implement a network of Remote Areas (Milan and Rome) connected to each other and also both connected to Internet.

### **USER REQUIREMENTS:**

- ◆ Public IP Block of **15.212.76.0/25** to be divided and shared among users and other node connections.
- ◆ The Network Infrastructure must be able to accommodate all users of the two remote sites.
- ◆ The Infrastructure must be scalable for future expansion and upgrade
- ◆ All the PC users must be accessible from Internet and should be able to access Internet
- ◆ Users in one remote site should be reached from the other remote area and vice versa.
- ◆ Printers in one remote site should be accessible **only** the PC users of the site and vice versa.
- ◆ Printers from both remote sites must not be reachable from Internet.
- ◆ Peer to peer networks must not waste any address on subnet.

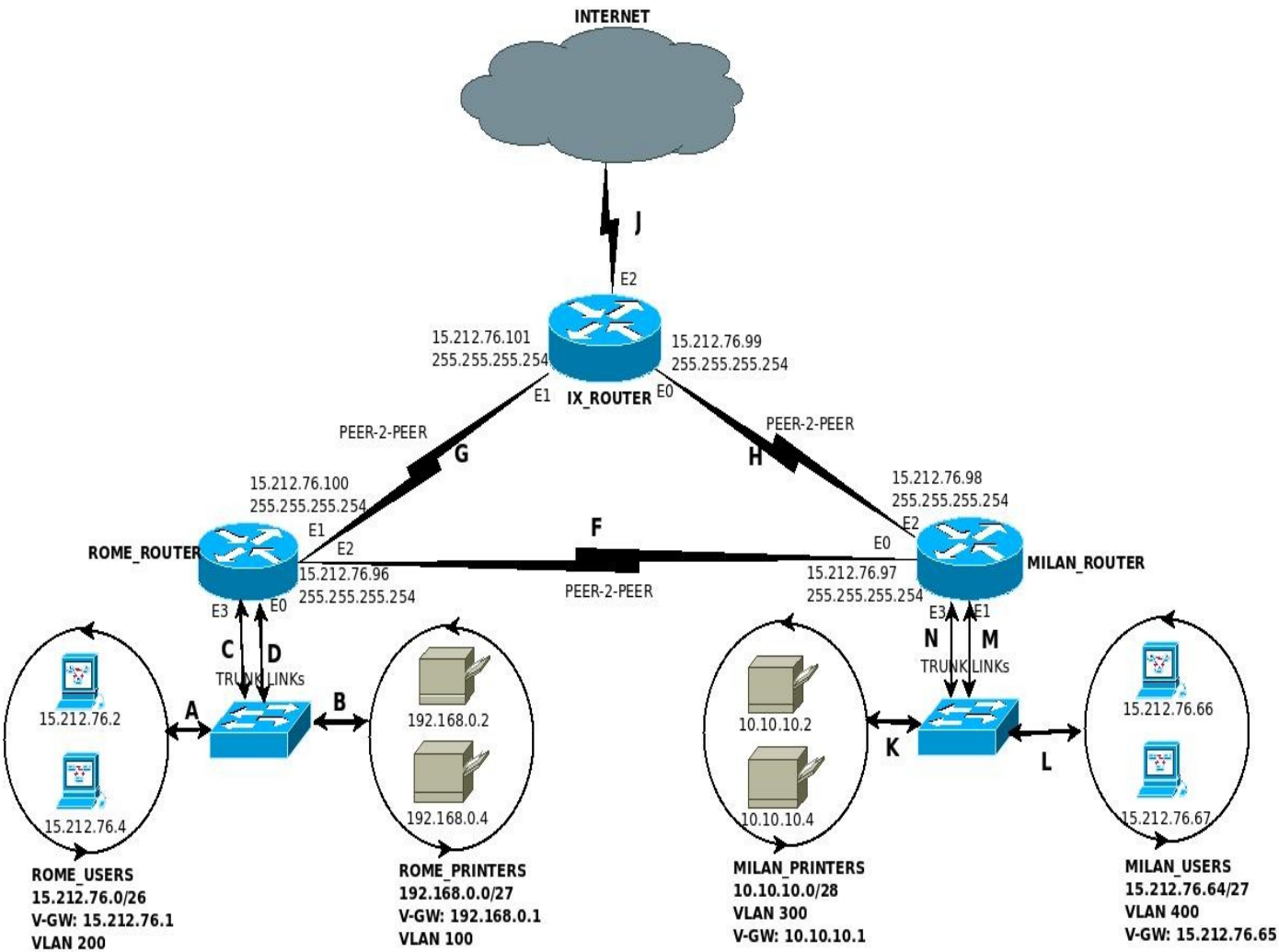
## IP ADDRESS PLAN FOR NODES AND SUBNETWORKS

CONNECTIONS	SUBNETWORKS	MAXIMUM USERS
Rome PC Users	<b>15.212.76.0/26</b>	60
Milan PC Users	<b>15.212.76.64/27</b>	30
Rome-Milan P2P	<b>15.212.76.96/31</b>	2
Rome-IX P2P	<b>15.212.76.100/31</b>	2
Milan-IX P2P	<b>15.212.76.98/31</b>	2
Milan Printers	<b>10.10.10.0/28</b>	14
Rome Printer	<b>192.168.0.0/27</b>	15

### REASON FOR IP ADDRESS CHOICE:

- ◆ Subnetwork **15.212.76.0/26** has 62 available addresses, which is enough for 60 PC users in Rome
- ◆ Subnetwork **15.212.76.64/27** has 30 available addresses enough to take care of 26 Milan PCs.
- ◆ Subnetwork **15.212.76.96/31** has maximum of 2 users enough for the peer to peer connection between Rome and Milan gateways.
- ◆ Subnetwork **15.212.76.100/31** has 2 addresses enough for the peer to peer connection between Rome and Internet Exchange gateways.
- ◆ Subnetwork **15.212.76.98/31** also has 2 addresses to take care of Milan to Internet Exchange peer -to-peer connection
- ◆ **Printers from both remote sites do not need to be reached beyond their respective domains and should be be accessible via Internet so we chose Private IP subnet addresses for the connections.**
- ◆ Subnet **10.10.10.0/28** has assigned to Milan's 7 Printers
- ◆ Subnet **192.168.0.0/27** has been assigned to Rome's 15 Printers.

NETWORK DESIGN DIAGRAM



## DESIGN CHOICES AND TECHNIQUES

	Interface	IP Address	Netmask	Broadcast	Connections
<b>Pc1-Rome</b>	eth0	15.212.76.2	255.255.255.192	15.212.76.63	A
<b>Pc2-Rome</b>	eth0	15.212.76.4	255.255.255.192	15.212.76.63	A
<b>Printer1-Rome</b>	eth0	192.168.0.2	255.255.255.224	192.168.0.31	B
<b>Printer2-Rome</b>	eth0	192.168.0.4	255.255.255.224	192.168.0.31	B
<b>Switch-Rome</b>	eth0 eth1 eth2 eth3 eth4 eth5				A A C B B D
<b>Router-Rome</b>	eth0.200 eth3.100 eth1 eth2	15.212.76.65 192.168.0.1 15.212.76.96 15.212.76.100	255.255.255.192 255.255.255.224 255.255.255.254 255.255.255.254	15.212.76.63 192.168.0.31	C D G F
<b>Pc1-Milan</b>	eth0	15.212.76.66	255.255.255.224	15.212.76.95	L
<b>Pc2-Milan</b>	eth0	15.212.76.67	255.255.255.224	15.212.76.95	L
<b>Printer1-Milan</b>	eth0	10.10.10.2	255.255.255.240	10.10.10.15	K
<b>Printer2-Milan</b>	eth0	10.10.10.4	255.255.255.240	10.10.10.15	K
<b>Switch-Milan</b>	eth0 eth1 eth2 eth3 eth4 eth5				L L M K K N
<b>Router-Milan</b>	eth1.400 eth3.300 eth2 eth3	15.212.76.65 10.10.10.1 15.212.76.98 15.212.76.97	255.255.255.224 255.255.255.240 255.255.255.254 255.255.255.254		M N H F
<b>Router-IX</b>	eth0 eth1	15.212.76.101 15.212.76.99	255.255.255.254 255.255.255.254		H G

## TECHNOLOGIES DEPLOYED:

**VLAN:** Vlan technology was deployed at both remote sites to separate the Printers from PC users. For instance, in each of the sites ( Milan and Rome), there is PC Users subnet and Printers' subnet.

**Routing:** In order for two or more networks to communicate, **static routing** was configured to route traffic from one subnet to another.

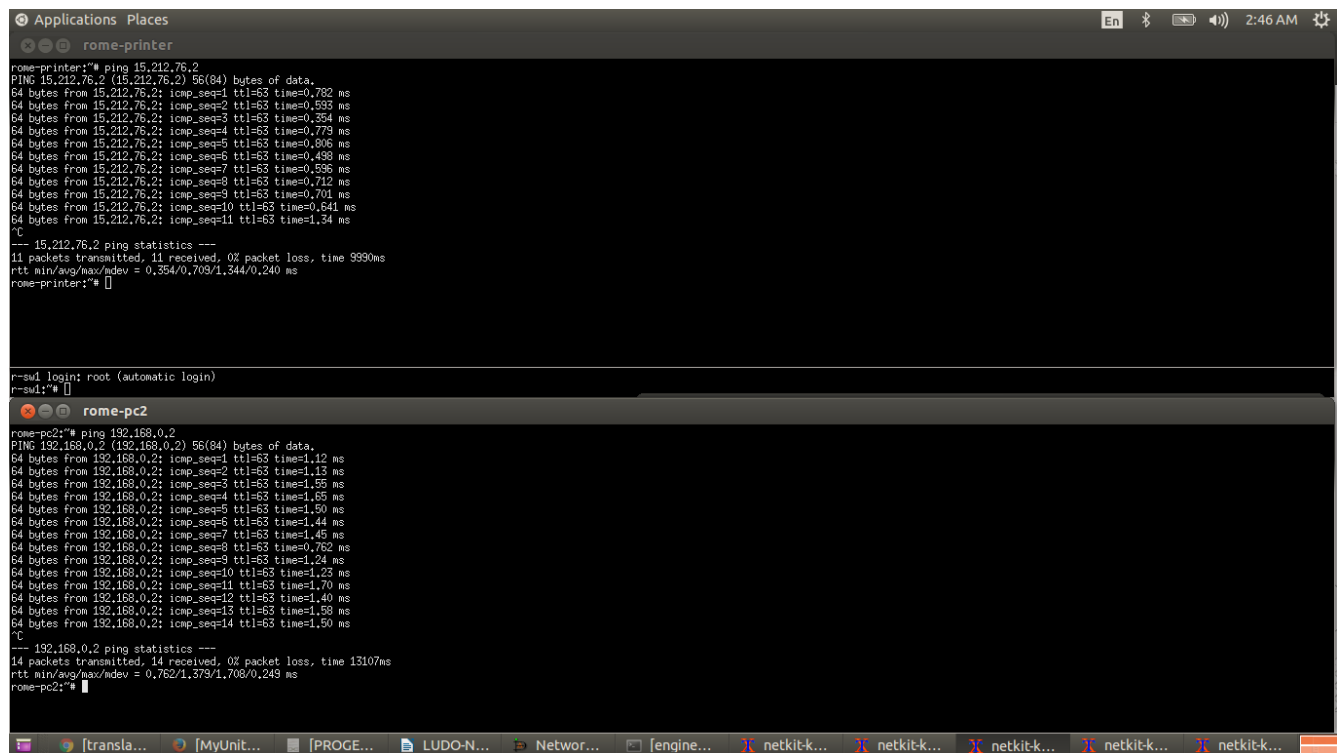
**Inter-VLAN Routing:** For Vlans to communicate, IEEE **802.1Q protocol** was enable on both Milan and Rome gateway routers for inter-vlan routing among Vlans networks.

**Netkit Simulation:** Network design was implemented by using Netkit Simulation tool with linux commands.

*Scripts of the Netkit simulation implementation is attached to this documents*

## IMPLEMENTATION OF NETWORK DESIGN WITH NETKIT

- ◆ Remote sites' users must be able to print locally from their printers

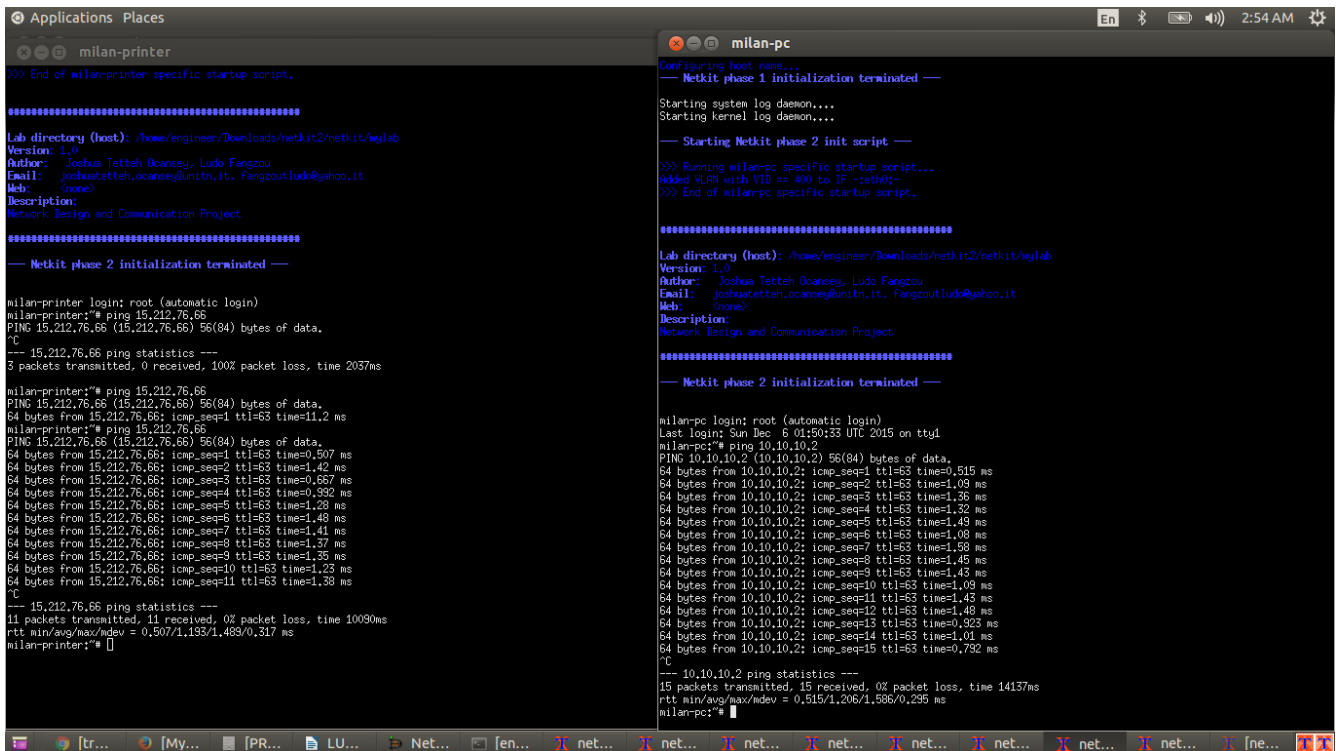


```
Applications Places
rome-printer
rome-printer:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data:
64 bytes from 15.212.76.2: icmp_seq=1 ttl=63 time=0.782 ms
64 bytes from 15.212.76.2: icmp_seq=2 ttl=63 time=0.583 ms
64 bytes from 15.212.76.2: icmp_seq=3 ttl=63 time=0.354 ms
64 bytes from 15.212.76.2: icmp_seq=4 ttl=63 time=0.779 ms
64 bytes from 15.212.76.2: icmp_seq=5 ttl=63 time=0.806 ms
64 bytes from 15.212.76.2: icmp_seq=6 ttl=63 time=0.498 ms
64 bytes from 15.212.76.2: icmp_seq=7 ttl=63 time=0.556 ms
64 bytes from 15.212.76.2: icmp_seq=8 ttl=63 time=0.712 ms
64 bytes from 15.212.76.2: icmp_seq=9 ttl=63 time=0.701 ms
64 bytes from 15.212.76.2: icmp_seq=10 ttl=63 time=0.541 ms
64 bytes from 15.212.76.2: icmp_seq=11 ttl=63 time=1.134 ms
^C
--- 15.212.76.2 ping statistics ---
11 packets transmitted, 11 received, 0% packet loss, time 9990ms
rtt min/avg/max/mdev = 0.354/0.709/1.344/0.240 ms
rome-printer:~#

r-sm1 login: root (automatic login)
r-sm1:~#

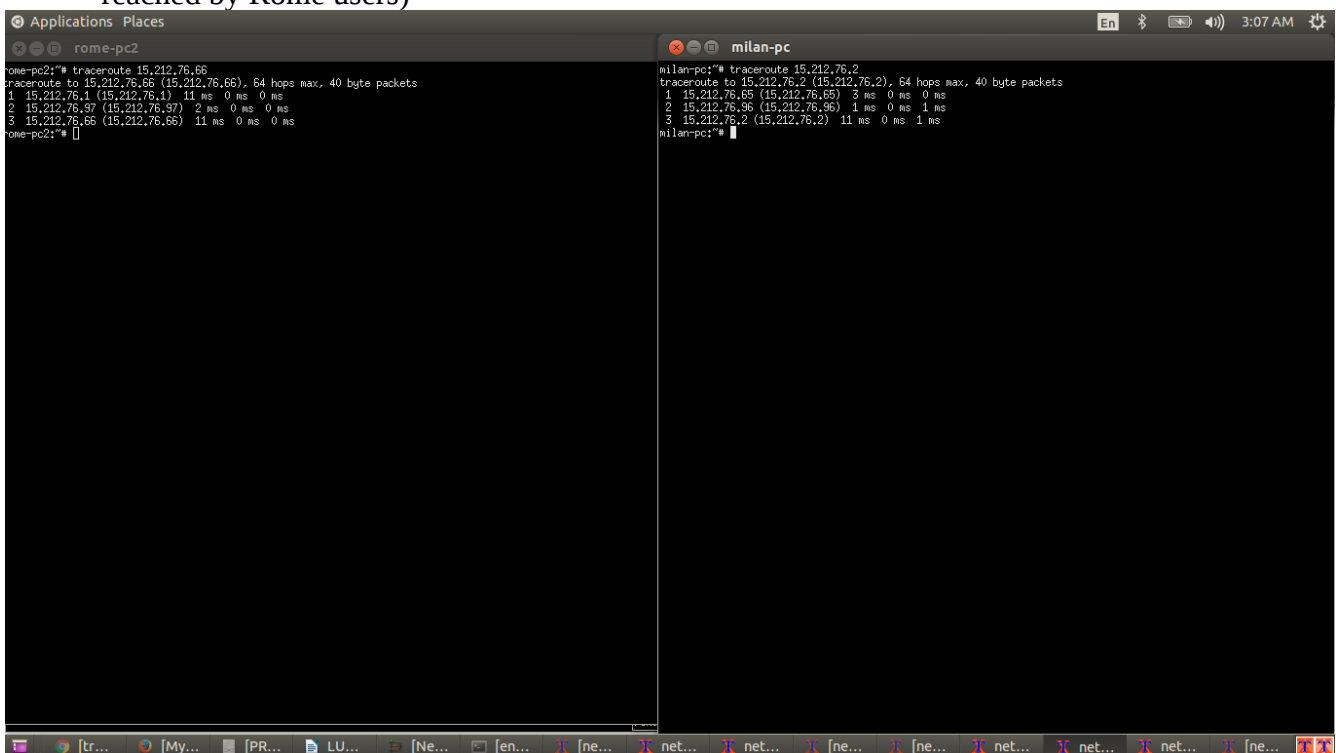
rome-pc2
rome-pc2:~# ping 192.168.0.2
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data:
64 bytes from 192.168.0.2: icmp_seq=1 ttl=63 time=1.12 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=63 time=1.13 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=63 time=1.55 ms
64 bytes from 192.168.0.2: icmp_seq=4 ttl=63 time=1.65 ms
64 bytes from 192.168.0.2: icmp_seq=5 ttl=63 time=1.50 ms
64 bytes from 192.168.0.2: icmp_seq=6 ttl=63 time=1.44 ms
64 bytes from 192.168.0.2: icmp_seq=7 ttl=63 time=1.45 ms
64 bytes from 192.168.0.2: icmp_seq=8 ttl=63 time=0.762 ms
64 bytes from 192.168.0.2: icmp_seq=9 ttl=63 time=1.24 ms
64 bytes from 192.168.0.2: icmp_seq=10 ttl=63 time=1.23 ms
64 bytes from 192.168.0.2: icmp_seq=11 ttl=63 time=1.70 ms
64 bytes from 192.168.0.2: icmp_seq=12 ttl=63 time=1.40 ms
64 bytes from 192.168.0.2: icmp_seq=13 ttl=63 time=1.58 ms
64 bytes from 192.168.0.2: icmp_seq=14 ttl=63 time=1.50 ms
^C
--- 192.168.0.2 ping statistics ---
14 packets transmitted, 14 received, 0% packet loss, time 13107ms
rtt min/avg/max/mdev = 0.762/1.379/1.708/0.249 ms
rome-pc2:~#
```

**Fig 1: Showing ping command to test from Rome Pc to Rome Printer**



**Fig 2: Showing Ping to demonstrate connection between Milan PC and Milan printer**

- ◆ Remote sites users must be able to connect each other and vice versa (eg Milan users must be reached by Rome users)



**Fig 3: Traceroute command showing connection between Rome PC and Milan PC.**

- ◆ Remote users must be reachable from Internet and remote users must access Internet.

The screenshot shows two terminal windows. The left window, titled 'ie-gw', displays the output of a 'ping 15.212.76.66' command. It shows 35 successful pings with a 0% packet loss and a round-trip time of approximately 0.45ms. The right window, titled 'milan-pc', shows the output of a 'tracert 15.212.76.2' command, which successfully traces the path to the destination IP address. Below the traceroute, it shows the output of a 'ping 15.212.76.101' command, which also shows 25 successful pings with a 0% packet loss and a round-trip time of approximately 0.18ms.

```
ie-gw login: root (automatic login)
ie-gw# ping 15.212.76.66
PING 15.212.76.66 (15.212.76.66) 56(84) bytes of data:
64 bytes from 15.212.76.66: icmp_seq=1 ttl=63 time=0.543 ms
64 bytes from 15.212.76.66: icmp_seq=2 ttl=63 time=1.08 ms
64 bytes from 15.212.76.66: icmp_seq=3 ttl=63 time=1.16 ms
64 bytes from 15.212.76.66: icmp_seq=4 ttl=63 time=1.17 ms
64 bytes from 15.212.76.66: icmp_seq=5 ttl=63 time=1.07 ms
64 bytes from 15.212.76.66: icmp_seq=6 ttl=63 time=0.821 ms
64 bytes from 15.212.76.66: icmp_seq=7 ttl=63 time=1.04 ms
64 bytes from 15.212.76.66: icmp_seq=8 ttl=63 time=1.10 ms
64 bytes from 15.212.76.66: icmp_seq=9 ttl=63 time=0.475 ms
64 bytes from 15.212.76.66: icmp_seq=10 ttl=63 time=1.05 ms
64 bytes from 15.212.76.66: icmp_seq=11 ttl=63 time=0.883 ms
64 bytes from 15.212.76.66: icmp_seq=12 ttl=63 time=1.18 ms
64 bytes from 15.212.76.66: icmp_seq=13 ttl=63 time=1.03 ms
64 bytes from 15.212.76.66: icmp_seq=14 ttl=63 time=1.12 ms
64 bytes from 15.212.76.66: icmp_seq=15 ttl=63 time=0.968 ms
64 bytes from 15.212.76.66: icmp_seq=16 ttl=63 time=1.04 ms
64 bytes from 15.212.76.66: icmp_seq=17 ttl=63 time=0.749 ms
64 bytes from 15.212.76.66: icmp_seq=18 ttl=63 time=0.765 ms
64 bytes from 15.212.76.66: icmp_seq=19 ttl=63 time=0.538 ms
64 bytes from 15.212.76.66: icmp_seq=20 ttl=63 time=1.24 ms
64 bytes from 15.212.76.66: icmp_seq=21 ttl=63 time=0.903 ms
64 bytes from 15.212.76.66: icmp_seq=22 ttl=63 time=0.651 ms
64 bytes from 15.212.76.66: icmp_seq=23 ttl=63 time=0.682 ms
64 bytes from 15.212.76.66: icmp_seq=24 ttl=63 time=0.807 ms
64 bytes from 15.212.76.66: icmp_seq=25 ttl=63 time=0.554 ms
64 bytes from 15.212.76.66: icmp_seq=26 ttl=63 time=0.450 ms
64 bytes from 15.212.76.66: icmp_seq=27 ttl=63 time=0.561 ms
64 bytes from 15.212.76.66: icmp_seq=28 ttl=63 time=0.585 ms
64 bytes from 15.212.76.66: icmp_seq=29 ttl=63 time=0.702 ms
64 bytes from 15.212.76.66: icmp_seq=30 ttl=63 time=0.707 ms
64 bytes from 15.212.76.66: icmp_seq=31 ttl=63 time=0.734 ms
64 bytes from 15.212.76.66: icmp_seq=32 ttl=63 time=0.537 ms
64 bytes from 15.212.76.66: icmp_seq=33 ttl=63 time=0.506 ms
64 bytes from 15.212.76.66: icmp_seq=34 ttl=63 time=0.641 ms
64 bytes from 15.212.76.66: icmp_seq=35 ttl=63 time=0.743 ms
^C
-- 15.212.76.66 ping statistics --
35 packets transmitted, 35 received, 0% packet loss, time 34180ms
rtt min/avg/max/mdev = 0.450/0.840/1.240/0.235 ms
ie-gw#
```

```
milan-pc
Mounting /home/engineer/Downloads/netkit2/netkit/nylab on /hostlab ...
Configuring host name...
milan-pc# traceroute 15.212.76.2
traceroute to 15.212.76.2 (15.212.76.2), 64 hops max, 40 byte packets
 1 15.212.76.66 (15.212.76.66) 3 ms 0 ms 0 ms
 2 15.212.76.96 (15.212.76.96) 1 ms 0 ms 1 ms
 3 15.212.76.2 (15.212.76.2) 11 ms 0 ms 1 ms
milan-pc# ping 15.212.76.101
PING 15.212.76.101 (15.212.76.101) 56(84) bytes of data:
64 bytes from 15.212.76.101: icmp_seq=1 ttl=63 time=0.51 ms
64 bytes from 15.212.76.101: icmp_seq=2 ttl=63 time=1.29 ms
64 bytes from 15.212.76.101: icmp_seq=3 ttl=63 time=0.553 ms
64 bytes from 15.212.76.101: icmp_seq=4 ttl=63 time=0.186 ms
64 bytes from 15.212.76.101: icmp_seq=5 ttl=63 time=0.590 ms
64 bytes from 15.212.76.101: icmp_seq=6 ttl=63 time=0.309 ms
64 bytes from 15.212.76.101: icmp_seq=7 ttl=63 time=0.562 ms
64 bytes from 15.212.76.101: icmp_seq=8 ttl=63 time=0.510 ms
64 bytes from 15.212.76.101: icmp_seq=9 ttl=63 time=0.432 ms
64 bytes from 15.212.76.101: icmp_seq=10 ttl=63 time=0.536 ms
64 bytes from 15.212.76.101: icmp_seq=11 ttl=63 time=0.609 ms
64 bytes from 15.212.76.101: icmp_seq=12 ttl=63 time=0.463 ms
64 bytes from 15.212.76.101: icmp_seq=13 ttl=63 time=0.715 ms
64 bytes from 15.212.76.101: icmp_seq=14 ttl=63 time=0.507 ms
64 bytes from 15.212.76.101: icmp_seq=15 ttl=63 time=0.462 ms
64 bytes from 15.212.76.101: icmp_seq=16 ttl=63 time=0.543 ms
64 bytes from 15.212.76.101: icmp_seq=17 ttl=63 time=0.473 ms
64 bytes from 15.212.76.101: icmp_seq=18 ttl=63 time=0.716 ms
64 bytes from 15.212.76.101: icmp_seq=19 ttl=63 time=0.184 ms
64 bytes from 15.212.76.101: icmp_seq=20 ttl=63 time=0.288 ms
64 bytes from 15.212.76.101: icmp_seq=21 ttl=63 time=0.388 ms
64 bytes from 15.212.76.101: icmp_seq=22 ttl=63 time=0.277 ms
64 bytes from 15.212.76.101: icmp_seq=23 ttl=63 time=0.303 ms
64 bytes from 15.212.76.101: icmp_seq=24 ttl=63 time=0.445 ms
64 bytes from 15.212.76.101: icmp_seq=25 ttl=63 time=0.403 ms
^C
-- 15.212.76.101 ping statistics --
25 packets transmitted, 25 received, 0% packet loss, time 24023ms
rtt min/avg/max/mdev = 0.184/0.610/3.512/0.630 ms
milan-pc#
```

Fig 4: Ping activities showing connection from Internet Exchange router to Milan PC

The screenshot shows two terminal windows. The left window, titled 'ie-gw', displays the output of a 'ping 15.212.76.2' command. It shows 46 successful pings with a 0% packet loss and a round-trip time of approximately 0.46ms. The right window, titled 'rome-pc', shows the output of a 'tracert 15.212.76.99' command, which successfully traces the path to the destination IP address. Below the traceroute, it shows the output of a 'ping 15.212.76.99' command, which also shows 3 successful pings with a 0% packet loss and a round-trip time of approximately 0.3ms.

```
ie-gw
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data:
64 bytes from 15.212.76.2: icmp_seq=1 ttl=63 time=0.463 ms
64 bytes from 15.212.76.2: icmp_seq=2 ttl=63 time=0.682 ms
64 bytes from 15.212.76.2: icmp_seq=3 ttl=63 time=0.787 ms
64 bytes from 15.212.76.2: icmp_seq=4 ttl=63 time=1.07 ms
64 bytes from 15.212.76.2: icmp_seq=5 ttl=63 time=1.05 ms
64 bytes from 15.212.76.2: icmp_seq=6 ttl=63 time=0.550 ms
64 bytes from 15.212.76.2: icmp_seq=7 ttl=63 time=1.00 ms
64 bytes from 15.212.76.2: icmp_seq=8 ttl=63 time=0.907 ms
64 bytes from 15.212.76.2: icmp_seq=9 ttl=63 time=0.509 ms
64 bytes from 15.212.76.2: icmp_seq=10 ttl=63 time=1.21 ms
64 bytes from 15.212.76.2: icmp_seq=11 ttl=63 time=0.703 ms
64 bytes from 15.212.76.2: icmp_seq=12 ttl=63 time=1.04 ms
64 bytes from 15.212.76.2: icmp_seq=13 ttl=63 time=0.591 ms
64 bytes from 15.212.76.2: icmp_seq=14 ttl=63 time=1.26 ms
64 bytes from 15.212.76.2: icmp_seq=15 ttl=63 time=1.09 ms
64 bytes from 15.212.76.2: icmp_seq=16 ttl=63 time=0.763 ms
64 bytes from 15.212.76.2: icmp_seq=17 ttl=63 time=1.17 ms
64 bytes from 15.212.76.2: icmp_seq=18 ttl=63 time=1.04 ms
64 bytes from 15.212.76.2: icmp_seq=19 ttl=63 time=1.15 ms
64 bytes from 15.212.76.2: icmp_seq=20 ttl=63 time=1.14 ms
64 bytes from 15.212.76.2: icmp_seq=21 ttl=63 time=0.996 ms
64 bytes from 15.212.76.2: icmp_seq=22 ttl=63 time=1.00 ms
64 bytes from 15.212.76.2: icmp_seq=23 ttl=63 time=1.04 ms
64 bytes from 15.212.76.2: icmp_seq=24 ttl=63 time=0.837 ms
64 bytes from 15.212.76.2: icmp_seq=25 ttl=63 time=1.02 ms
64 bytes from 15.212.76.2: icmp_seq=26 ttl=63 time=0.940 ms
64 bytes from 15.212.76.2: icmp_seq=27 ttl=63 time=0.638 ms
64 bytes from 15.212.76.2: icmp_seq=28 ttl=63 time=0.868 ms
64 bytes from 15.212.76.2: icmp_seq=29 ttl=63 time=1.09 ms
64 bytes from 15.212.76.2: icmp_seq=30 ttl=63 time=1.04 ms
64 bytes from 15.212.76.2: icmp_seq=31 ttl=63 time=0.626 ms
64 bytes from 15.212.76.2: icmp_seq=32 ttl=63 time=1.09 ms
64 bytes from 15.212.76.2: icmp_seq=33 ttl=63 time=1.09 ms
64 bytes from 15.212.76.2: icmp_seq=34 ttl=63 time=1.11 ms
64 bytes from 15.212.76.2: icmp_seq=35 ttl=63 time=1.14 ms
64 bytes from 15.212.76.2: icmp_seq=36 ttl=63 time=1.07 ms
64 bytes from 15.212.76.2: icmp_seq=37 ttl=63 time=0.947 ms
64 bytes from 15.212.76.2: icmp_seq=38 ttl=63 time=0.567 ms
64 bytes from 15.212.76.2: icmp_seq=39 ttl=63 time=1.12 ms
64 bytes from 15.212.76.2: icmp_seq=40 ttl=63 time=1.02 ms
64 bytes from 15.212.76.2: icmp_seq=41 ttl=63 time=1.11 ms
64 bytes from 15.212.76.2: icmp_seq=42 ttl=63 time=0.949 ms
64 bytes from 15.212.76.2: icmp_seq=43 ttl=63 time=1.06 ms
64 bytes from 15.212.76.2: icmp_seq=44 ttl=63 time=0.985 ms
64 bytes from 15.212.76.2: icmp_seq=45 ttl=63 time=1.11 ms
64 bytes from 15.212.76.2: icmp_seq=46 ttl=63 time=0.949 ms
^C
-- 15.212.76.2 ping statistics --
46 packets transmitted, 46 received, 0% packet loss, time 45424ms
rtt min/avg/max/mdev = 0.463/0.977/1.255/0.175 ms
ie-gw#
```

```
rome-pc
rome-pc# Traceroute 15.212.76.99
bash: Traceroute: command not found
rome-pc# traceroute 15.212.76.99
traceroute to 15.212.76.99 (15.212.76.99), 64 hops max, 40 byte packets
 1 15.212.76.1 (15.212.76.1) 1 ms 0 ms 0 ms
 2 15.212.76.97 (15.212.76.97) 0 ms 1 ms 1 ms
 3 15.212.76.99 (15.212.76.99) 3 ms 0 ms 0 ms
rome-pc#
rome-pc#
```

Fig 5: Ping and traceroute commands showing connection between Internet exchange Router gateway and Rome PC

- ◆ Printers in each remote sites **must not** be reachable from other remote site and from the Internet

```
Applications Places
ie-gw
rtt min/avg/max/ndev = 0.357/0.760/1.205/0.236 ms
ie-gw:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data.
ie-gw:~# ping 10.10.10.2
connect: Network is unreachable
ie-gw:~# ping 192.168.0.2
connect: Network is unreachable
ie-gw:~#

rome-printer
rome-printer:~# ping 15.212.76.101
PING 15.212.76.101 (15.212.76.101) 56(84) bytes of data.
^C
--- 15.212.76.101 ping statistics ---
19 packets transmitted, 0 received, 100% packet loss, time 18010ms
rome-printer:~#
```

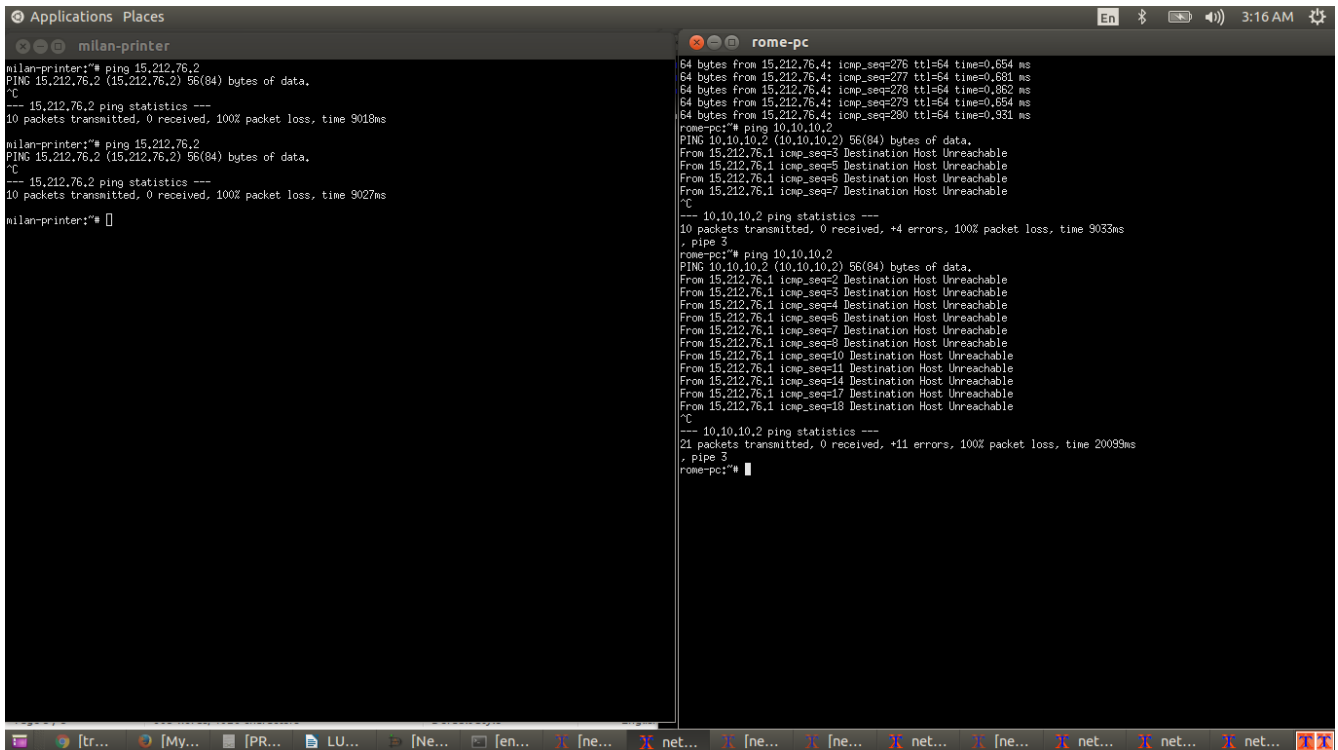
**Fig 6: Ping Results showing that Printer in Rome is not reachable from Internet ( Internet Exchange)**

```
Applications Places
ie-gw
ie-gw:~# ping 10.10.10.2
connect: Network is unreachable
ie-gw:~#

milan-printer
milan-printer:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data.
^C
--- 15.212.76.2 ping statistics ---
10 packets transmitted, 0 received, 100% packet loss, time 9018ms
milan-printer:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data.
^C
--- 15.212.76.2 ping statistics ---
10 packets transmitted, 0 received, 100% packet loss, time 9027ms
milan-printer:~# ping 15.212.76.99
PING 15.212.76.99 (15.212.76.99) 56(84) bytes of data.
^C
```

**Fig 7: Ping results showing that Milan Printer can not be reachable from Internet ( Internet IX)**





```
Applications Places
milan-printer
milan-printer:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data.
^C
--- 15.212.76.2 ping statistics ---
10 packets transmitted, 0 received, 100% packet loss, time 9018ms

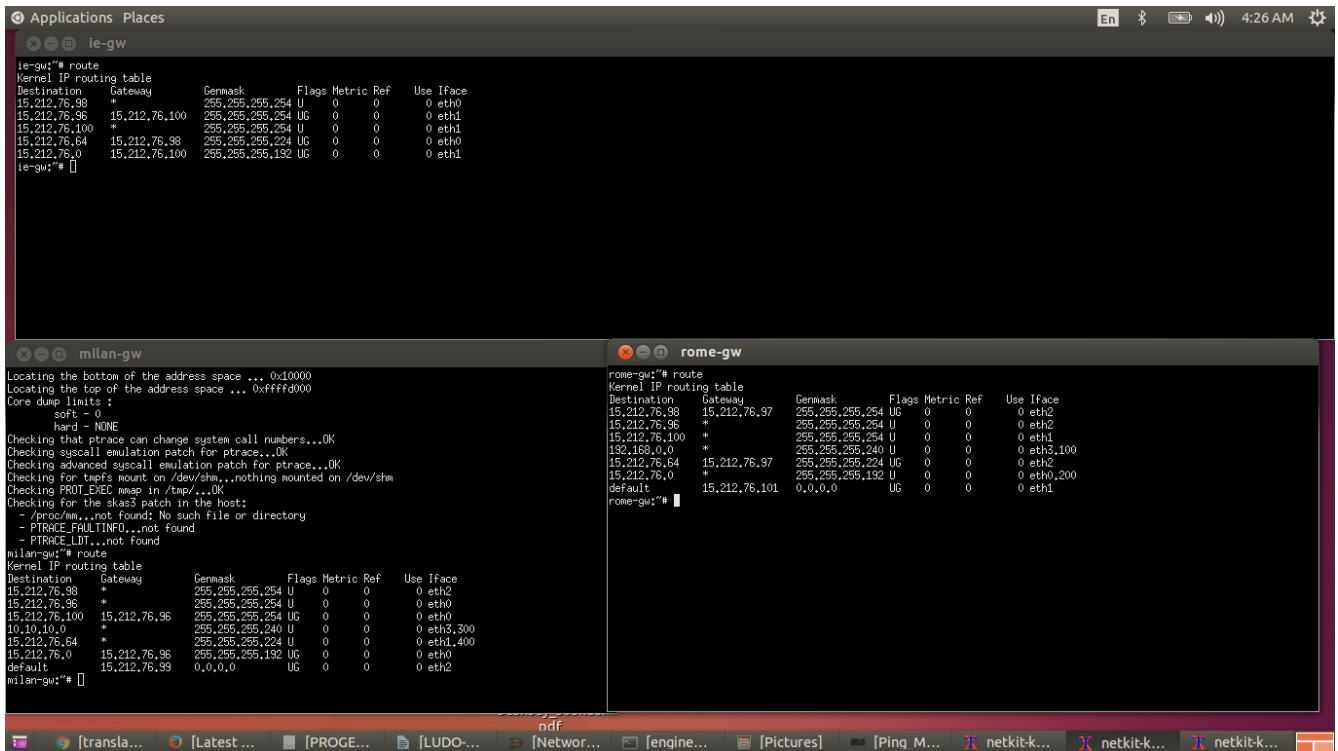
milan-printer:~# ping 15.212.76.2
PING 15.212.76.2 (15.212.76.2) 56(84) bytes of data.
^C
--- 15.212.76.2 ping statistics ---
10 packets transmitted, 0 received, 100% packet loss, time 9027ms

milan-printer:~# []

rome-pc
64 bytes from 15.212.76.4: icmp_seq=276 ttl=64 time=0.654 ms
64 bytes from 15.212.76.4: icmp_seq=277 ttl=64 time=0.681 ms
64 bytes from 15.212.76.4: icmp_seq=278 ttl=64 time=0.682 ms
64 bytes from 15.212.76.4: icmp_seq=279 ttl=64 time=0.654 ms
64 bytes from 15.212.76.4: icmp_seq=280 ttl=64 time=0.331 ms
rome-pc:~# ping 10.10.10.2
PING 10.10.10.2 (10.10.10.2) 56(84) bytes of data.
From 15.212.76.1: icmp_seq=5 Destination Host Unreachable
From 15.212.76.1: icmp_seq=6 Destination Host Unreachable
From 15.212.76.1: icmp_seq=7 Destination Host Unreachable
^C
--- 10.10.10.2 ping statistics ---
10 packets transmitted, 0 received, +4 errors, 100% packet loss, time 9033ms
, pipe 3
rome-pc:~# ping 10.10.10.2
PING 10.10.10.2 (10.10.10.2) 56(84) bytes of data.
From 15.212.76.1: icmp_seq=2 Destination Host Unreachable
From 15.212.76.1: icmp_seq=3 Destination Host Unreachable
From 15.212.76.1: icmp_seq=4 Destination Host Unreachable
From 15.212.76.1: icmp_seq=5 Destination Host Unreachable
From 15.212.76.1: icmp_seq=6 Destination Host Unreachable
From 15.212.76.1: icmp_seq=7 Destination Host Unreachable
From 15.212.76.1: icmp_seq=8 Destination Host Unreachable
From 15.212.76.1: icmp_seq=9 Destination Host Unreachable
From 15.212.76.1: icmp_seq=10 Destination Host Unreachable
From 15.212.76.1: icmp_seq=11 Destination Host Unreachable
From 15.212.76.1: icmp_seq=14 Destination Host Unreachable
From 15.212.76.1: icmp_seq=17 Destination Host Unreachable
From 15.212.76.1: icmp_seq=18 Destination Host Unreachable
^C
--- 10.10.10.2 ping statistics ---
21 packets transmitted, 0 received, +11 errors, 100% packet loss, time 20093ms
, pipe 3
rome-pc:~# []
```

**Fig 8: Ping results showing that Milan Printer is not accessible from Rome PC**

◆ Routing tables for the Gateway Routers showing routing links and matrices.



```
Applications Places
ie-gw
ie-gw:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
15.212.76.38 * 255.255.255.254 U 0 0 0 eth0
15.212.76.36 * 255.255.255.254 U 0 0 0 eth1
15.212.76.100 * 255.255.255.254 U 0 0 0 eth1
15.212.76.64 15.212.76.38 255.255.255.224 UG 0 0 0 eth0
15.212.76.0 15.212.76.100 255.255.255.192 UG 0 0 0 eth1
ie-gw:~# []

milan-gw
Locating the bottom of the address space ... 0x10000
Locating the top of the address space ... 0xffff0000
Core dump limits:
soft - 0
hard - NONE
Checking that ptrace can change system call numbers...OK
Checking syscall emulation patch for ptrace...OK
Checking advanced syscall emulation patch for ptrace...OK
Checking for tmpfs mount on /dev/shm...nothing mounted on /dev/shm
Checking PROT_EXEC mmap in /tmp...OK
Checking for the skas3 patch in the host:
- /proc/kallsyms...not found: No such file or directory
- PT_TRACE_FFAULTINFO...not found
- PT_TRACE_LDT...not found
milan-gw:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
15.212.76.38 * 255.255.255.254 U 0 0 0 eth2
15.212.76.36 * 255.255.255.254 U 0 0 0 eth0
15.212.76.100 15.212.76.36 255.255.255.254 UG 0 0 0 eth0
10.10.10.0 * 255.255.255.240 U 0 0 0 eth3.200
15.212.76.64 * 255.255.255.224 U 0 0 0 eth1.200
15.212.76.0 15.212.76.36 255.255.255.192 UG 0 0 0 eth0
default 15.212.76.39 0.0.0.0 UG 0 0 0 eth2
milan-gw:~# []

rome-gw
rome-gw:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
15.212.76.38 15.212.76.37 255.255.255.254 UG 0 0 0 eth2
15.212.76.36 * 255.255.255.254 U 0 0 0 eth2
15.212.76.100 * 255.255.255.254 U 0 0 0 eth1
192.168.0.0 * 255.255.255.240 U 0 0 0 eth3.100
15.212.76.64 15.212.76.37 255.255.255.224 UG 0 0 0 eth2
15.212.76.0 * 255.255.255.192 U 0 0 0 eth0.200
default 15.212.76.101 0.0.0.0 UG 0 0 0 eth1
rome-gw:~# []
```

**Fig 9. Routing table for each of the gateway routers ( ie Milan, Rome and Internet IX Router)**

### ASSUMPTIONS:

- ◆ IX Router is peered with other routers in the Exchange Server room for Internet.
- ◆ The two PC users on the topology at each remote site represent the entire block.
- ◆ The two printers at each site represent the entire printers to be connected on the network.
- ◆ The switch at each site represent the entire switches to be used for local Area Networks connections in both sites.

### CONCLUSION

The Network infrastructure designed above meets the specifications and can be scaled for future expansion and upgrade. Some of the required specifications are as follows:

- ◆ Both users from Milan and Rome sites can access Internet and can be reached from Internet.
- ◆ They Users from Milan and Rome can print from their respective Printers.
- ◆ Printers from respective sites are **not** accessible from public space or from Internet.
- ◆ Infrastructure can host at least the number of users and printers specified in the user requirement and has room for expansion.
- ◆ Infrastructure is capable of hosting and providing public services.