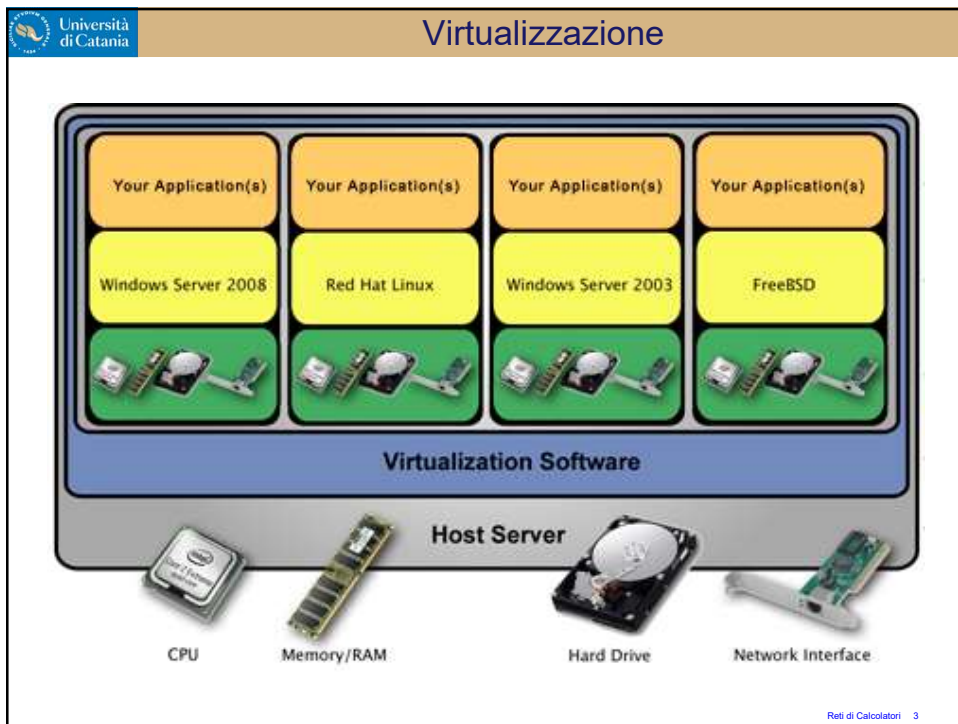


Destination	Gateway	Genmask	Flags	Iface
loopback	*	255.0.0.0	U	lo
link-local	*	255.255.0.0	U	eth0
192.168.0.0	*	255.255.255.0	U	eth0
default	192.168.0.1	0.0.0.0	UG	eth0





3



5

Università di Catania

VirtualBox

Oracle VM VirtualBox Gestore

File Macchina Aiuto

Strumenti

Preferenze

Importa

Esporta

Nuova

Aggiungi

Benvenuti in VirtualBox!

La parte sinistra di questa finestra contiene gli strumenti globali ed elenca tutte le macchine virtuali e i gruppi di macchine virtuali sul tuo computer. Puoi importare, aggiungere e creare nuove macchine virtuali utilizzando i pulsanti corrispondenti della barra degli strumenti. Puoi richiamare uno strumento dell'elemento selezionato utilizzando il pulsante corrispondente.

Puoi premere il tasto **F1** per ottenere aiuto immediatamente, o visitare www.virtualbox.org per ulteriori informazioni e per le ultime novità.

Reti di Calcolatori 6

6

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Virtualizzazione

Oracle VM VirtualBox Manager

New Settings Show Discard

eBusiness

Windows 8 Enterprise (RTM)

Running

Oracle Linux 6 U3

Running

Windows XP_1

Running

Mobile Platforms

Android Jelly-bean

Powered Off

Chrome OS

Powered Off

Windows

Windows 7 (x64)

Powered Off

Windows XP OBI

Powered Off

Windows 7

Saved

Windows Server 2012

Powered Off

Windows 8 Server

Saved

Linux

Ubuntu

Powered Off

Fedora 17

Saved

General

Name: Windows 8 Enterprise (RTM)

Operating System: Windows 8 (64 bit)

Groups: eBusiness

System

Base Memory: 2048 MB

Boot Order: Floppy, CD/DVD-ROM, Hard Disk

Acceleration: VT-x/AMD-V, Nested Paging

Preview

General

Name: Oracle Linux 6 U3

Operating System: Oracle (64 bit)

Groups: eBusiness

System

Base Memory: 1024 MB

Boot Order: Floppy, CD/DVD-ROM, Hard Disk

Acceleration: VT-x/AMD-V, Nested Paging, PAE/NX

Preview

General

Name: Windows XP_1

Operating System: Windows XP

Groups: eBusiness

System

Base Memory: 512 MB

Boot Order: Floppy, CD/DVD-ROM, Hard Disk

Acceleration: VT-x/AMD-V, Nested Paging

Preview

Reti di Calcolatori 7

7

Debian 10

Requisiti per l'installazione:

- RAM 1GB
- HD 2GB

Dopo l'installazione:

- RAM 256 (128) MB
- HD 1.6 GB

Consistent Network Device Naming is a convention for naming Ethernet adapters in Linux, that replace the old standard ethX which caused problems on multihomed machines because the network interface controllers (NICs) would get named based on the order in which they were found by the kernel as it booted. Added new interfaces could cause the previously added ones to change names

Scheme 3: Names incorporating physical location of the connector of the hardware (**example: enp2s0**), are applied if applicable

A volte il S.O. rinomina le interfacce di rete.

Nel file `/etc/udev/rules.d/70-persistent-net.rules` sono le indicazioni su come il S.O. sta attualmente rinominando le interfacce di rete.

```
user@nodeA /etc/udev/rules.d $ cat 70-persistent-net.rules
# This file was automatically generated by the
# /lib/udev/write_net_rules
# program, run by the persistent-net-generator.rules rules
# file.
#
# You can modify it, as long as you keep each rule on a
# single
# line, and change only the value of the NAME= key.

# PCI device 0x10ec:0x8168 (r8169)
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*",
ATTR{address}=="e0:db:55:cf:1d:d6", ATTR{dev_id}=="0x0",
ATTR{type}=="1", KERNEL=="eth*", NAME="eth0"
```

Deprecated command	Replacement command(s)
arp	ip n (ip neighbor)
ifconfig	ip a (ip addr), ip link, ip -s (ip -stats)
iptunnel	ip tunnel
iwconfig	iw
nameif	ip link, ifrename
netstat	ss, ip route (for netstat-r), ip -s link (for netstat-i), ip maddr (for netstat-g)
route	ip r (ip route)

ip addr

Show information for all addresses

ip addr show dev enp0s3

Display information only for device enp0s3

ip addr add 192.168.1.1/24 dev enp0s3

Add address 192.168.1.1 with netmask 24 to device enp0s3

ip addr del 192.168.1.1/24 dev enp0s3

Remove address 192.168.1.1/24 from device enp0s3

ip route

List all of the route entries in the kernel

ip route add default via 192.168.1.1 dev enp0s3

Add a default route (for all addresses) via the local gateway 192.168.1.1 that can be reached on device enp0s3

ip route add 192.168.1.0/24 via 192.168.1.1

Add a route to 192.168.1.0/24 via the gateway at 192.168.1.1

ip route delete 192.168.1.0/24 via 192.168.1.1

Delete the route for 192.168.1.0/24 via the gateway at 192.168.1.1

ip route replace 192.168.1.0/24 dev enp0s3

Replace the defined route for 192.168.1.0/24 to use device enp0s3

ip neigh

Display neighbour objects

ip neigh show dev enp0s3

Show the ARP cache for device enp0s3

ip neigh add 192.168.1.1 lladdr 1:2:3:4:5:6 dev enp0s3

Add address 192.168.1.1 with MAC 1:2:3:4:5:6 to enp0s3

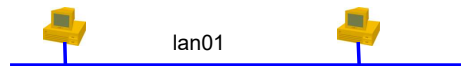
ip neigh del 192.168.1.1 dev enp0s3

Invalidate the entry for 192.168.1.1 on enp0s3

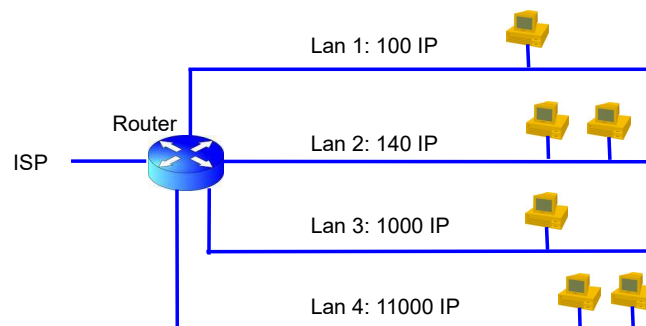
ip n replace 192.168.1.1 lladdr 1:2:3:4:5:6 dev enp0s3

Replace the entry for address 192.168.1.1 to use MAC 1:2:3:4:5:6 on enp0s3

Configurare 2 host in una lan virtuale.



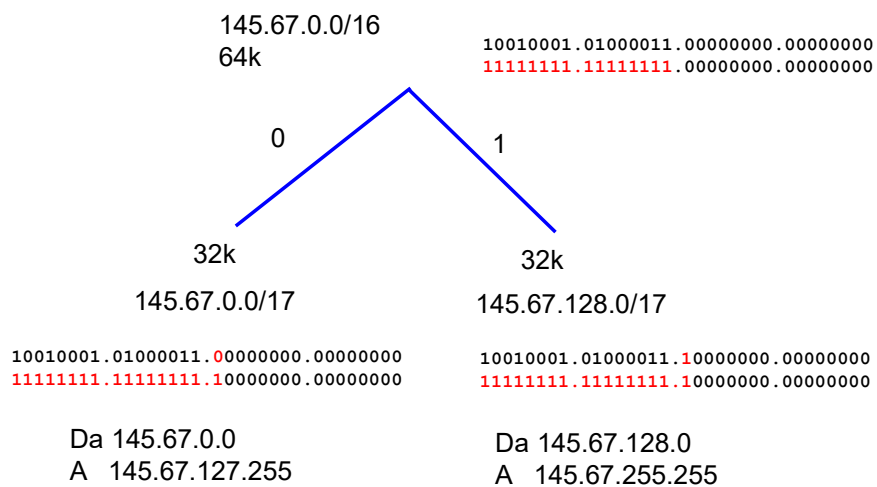
Una società ottiene la subnet 145.67.0.0/16
Configurare 4 subnet interne con i seguenti requisiti:



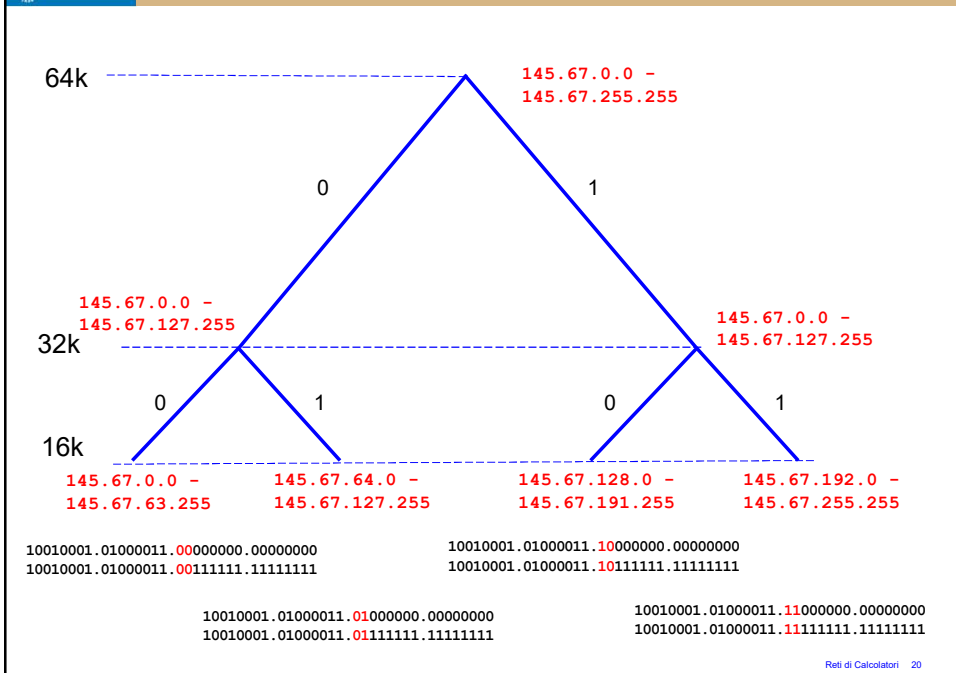
Garantire la massima espandibilità (ulteriori subnet interne)

145.67.0.0/16

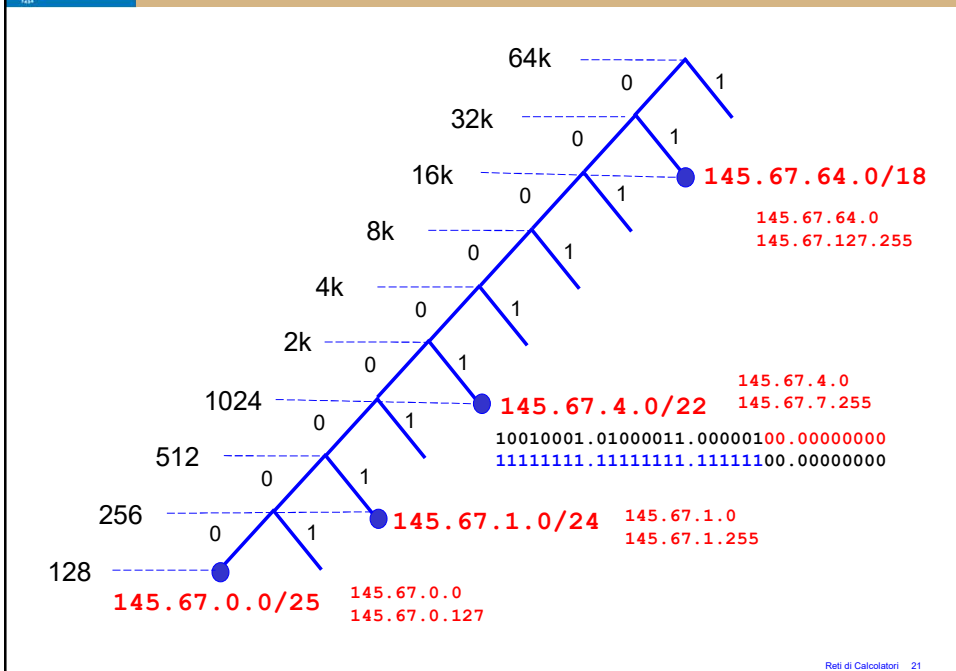
145.67.0.0 = 10010001.01000011.00000000.00000000
255.255.0.0 = 11111111.11111111.00000000.00000000



Esercizio 1 - soluzione

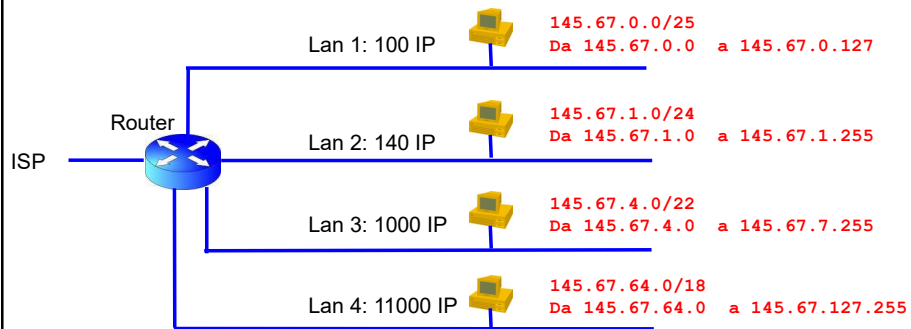


Esercizio 1 - soluzione



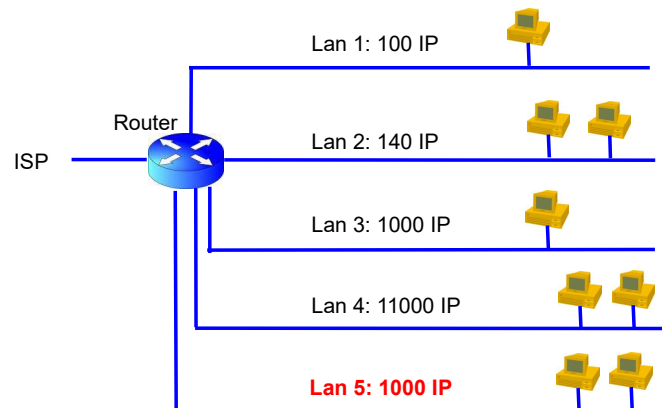
Esercizio 1 - soluzione

IP: 145.67.0.0/16

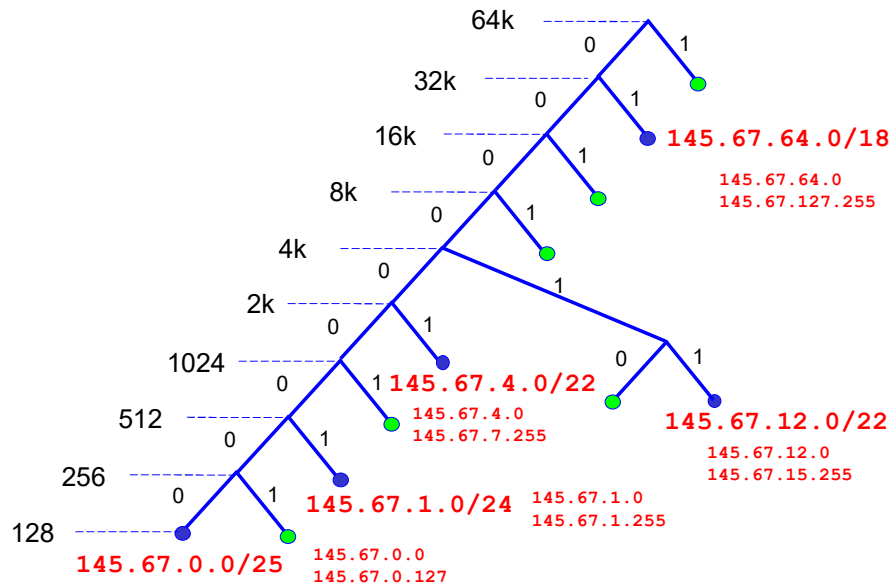


Esercizio 1 - espansione

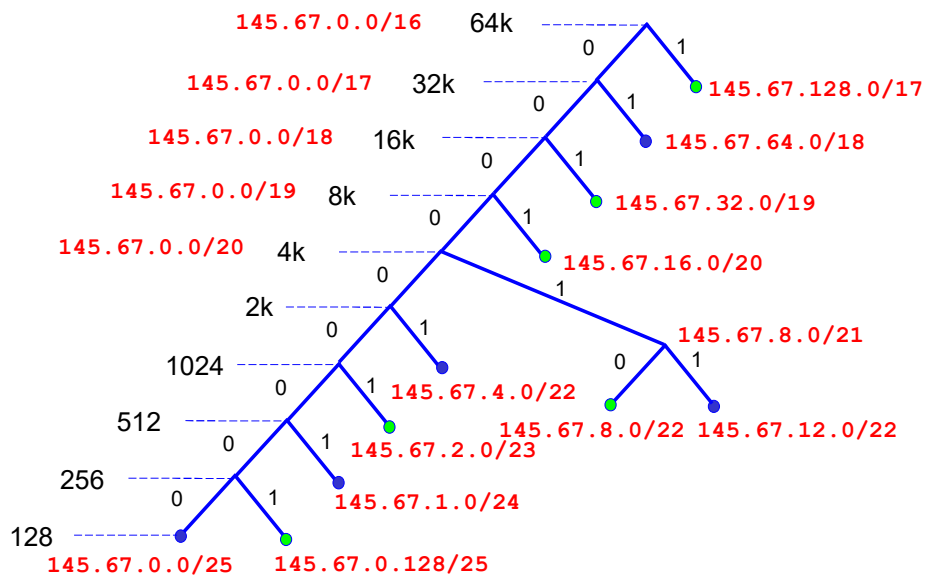
IP: 145.67.0.0/16



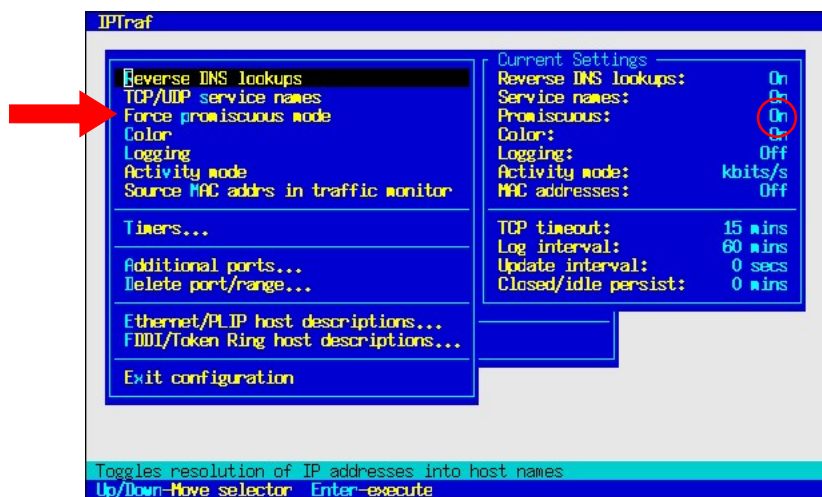
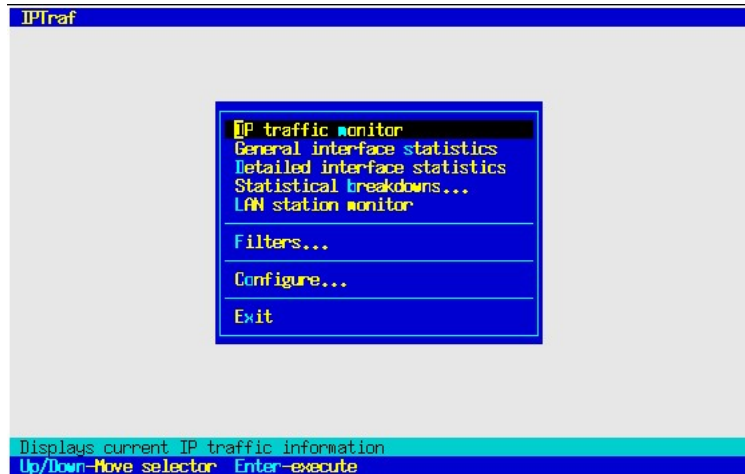
Esercizio 1 - espansione




Esercizio 1 - Indirizzi e maschere



Questo tool (da installare) consente di analizzare il traffico su un nodo o una interfaccia di rete





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iptraf

IPTraf

IP traffic monitor

General interface statistics

Det

Sta

LAN

Con

Exi

TCP...

UDP...

Other IP...

ARP

RARP

Non-IP

Exit menu

Filter Status

No TCP filter applied

All UDP visible

No misc IP filter applied

ARP not visible

RARP visible

Non-IP not visible

Filters affect the IP traffic monitor, interface statistics, and TCP/UDP protocol breakdown. The packet size breakdown and LAN monitor are unaffected.


Transmission Control Protocol

Up/Down-Move selector Enter-execute

Reti di Calcolatori

28

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iptraf

IPTraf

TCP Connections (Source Host:Port)

61.9.80.40:3812

61.9.4.185:http

61.9.80.38:1624

CPE3439373939323531.cpe.net.cabl:1214

boh141zoy4111.bc.hsia.telus.net:1214

61.9.80.38:1334

64.94.89.245:http

61.9.82.125:62620

61.9.82.125:63612

128.167.58.181:http

61.9.82.122:64399

h24-80-94-122.un.shawcable.net:1214

>

>

>

>

>

>

>

>

>

>

>

757

1001

528

832

1139

652

533

346

277

467

231

332

34822

1501198

24864

1245048

1704236

30790

760216

18567

13146

700500

11070

496592

--A-

-PA-

--A-

--A-

--A-

--A-

-PA-

--A-

--A-

--A-

--A-

-PA-

eth0

eth0

eth0

eth0

eth0

eth0

eth0

eth0

eth0

eth0

eth0

eth0

TCP: 6276 entries

Active

ARP request for 61.9.108.253 (46 bytes) from 00d0b7b7ea8d to 00000c4340a0 on

ARP reply from 61.9.108.253 (46 bytes) from 00000c4340a0 to 00d0b7b7ea8d on

ICMP echo req (84 bytes) from riker.mozcom.com to w4.dcx.yahoo.com on eth0

ICMP echo rply (84 bytes) from w4.dcx.yahoo.com to riker.mozcom.com on eth0

Non-IP (0x4) (46 bytes) from 00d0bacceb43 to 0180c2000000 on eth0

Non-IP (0x4) (46 bytes) from 00d0bacceb44 to 0180c2000000 on eth0

Bottom

Elapsed time: 0:03

Pkts captured (all interfaces): 208029

TCP flow rate: 148.40 kbits/s

Up/Dn/PgUp/PgDn-scroll M-more TCP info W-chg actu win S-sort TCP X-exit

Reti di Calcolatori

29

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IPtraf

	PktsIn	IP In	BytesIn	InRate	PktsOut	IP Out	BytesOut	OutRate
Ethernet HW addr: 0050dac010e9 on eth0	90	90	6401	0.0	128	127	8530	0.0
Ethernet HW addr: 0030f212f000 on eth0	133	133	8958	0.0	163	141	15589	2.0
Ethernet HW addr: 01005e000005 on eth0	75	75	11482	2.4	0	0	0	0.0
Ethernet HW addr: 00d0bacceb47 on eth0	0	0	0	0.0	18	0	1152	0.2
Ethernet HW addr: 0180c2000000 on eth0	18	0	1152	0.2	0	0	0	0.0
Ethernet HW addr: 00000c4340a0 on eth0	0	0	0	0.0	26	26	3724	0.6
Ethernet HW addr: 006097b77e2e on eth0	0	0	0	0.0	2	0	120	0.0
Ethernet HW addr: ffffffff on eth0	47	4	3672	0.4	0	0	0	0.0
Ethernet HW addr: 0050733f6b21 on eth0	0	0	0	0.0	4	0	240	0.0
Ethernet HW addr: 003094152f01 on eth0	0	0	0	0.0	15	15	2786	0.2

16 entries — Elapsed time: 0:00 — InRate and OutRate are in kbits/sec —
Up/Down/PgUp/PgDn-scroll window S-sort X-exit

Abilitazione IPv4 forwarding (di default è disabilitato). Se non è abilitato un host non si comporta da router.

`/etc/sysctl.conf`

cambiare 0 in 1 nella riga:

`net.ipv4.conf.ip_forward = 1`

Oppure per una modifica temporanea

`echo "1" > /proc/sys/net/ipv4/ip_forward`

```

1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group
default qlen 1000

    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP
group default qlen 1000

    link/ether 00:0c:29:1b:06:56 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.49/24 brd 192.168.0.255 scope global dynamic noprefixroute
    ens33
        valid_lft 84081sec preferred_lft 84081sec
    inet 10.0.0.1/24 scope global ens33
        valid_lft forever preferred_lft forever
    inet6 fe80::77c2:e823:81c5:e36f/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
  
```

```

#ip route
default via 192.168.0.1 dev ens33 proto dhcp metric 100
10.0.0.0/24 dev ens33 proto kernel scope link src 10.0.0.1
192.168.0.0/24 dev ens33 proto kernel scope link src 192.168.0.49 metric 100
  
```



```
ip addr add 1.1.1.1/24 dev enp0s3
```

Nodo A
1.1.1.1/24



Nodo B
1.1.1.2/24



Nodo C
1.1.1.3/24



Lan1

In automatico sarà generata la seguente riga di routing:

```
#ip route
```

```
10.1.1.0/24 dev enp0s3 proto kernel scope link src 10.1.1.1
```

Cosa succede in questa rete? Verificare sperimentalmente

Nodo A
1.1.1.1/16



Nodo B
1.1.2.2/16

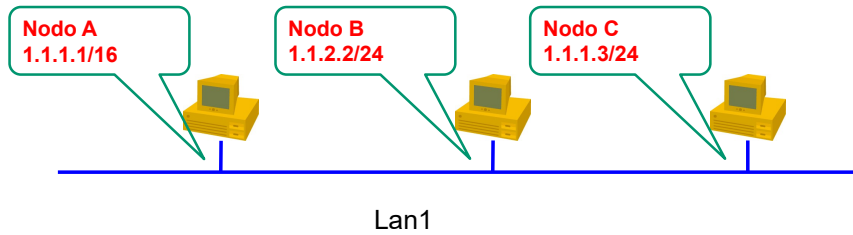


Nodo C
1.1.1.3/24



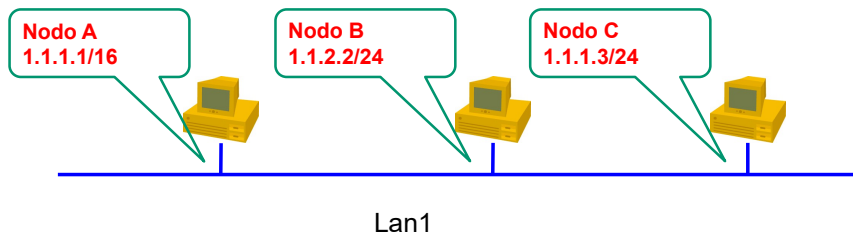
Lan1

Cambiamo la maschera del nodo B. Cosa succede?



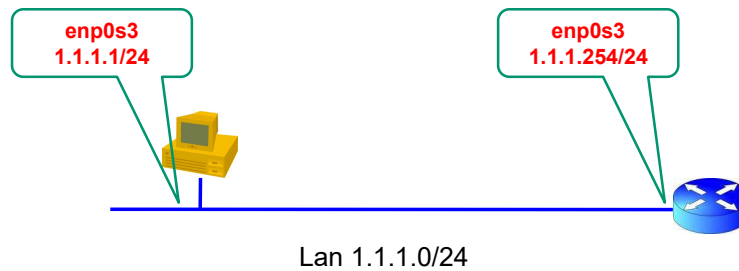
Il seguente comando configura la scheda di rete in modalità promiscua (accetta tutte le frame, anche con MAC address diverso dal proprio).

```
ip link set [interface] promisc on
```



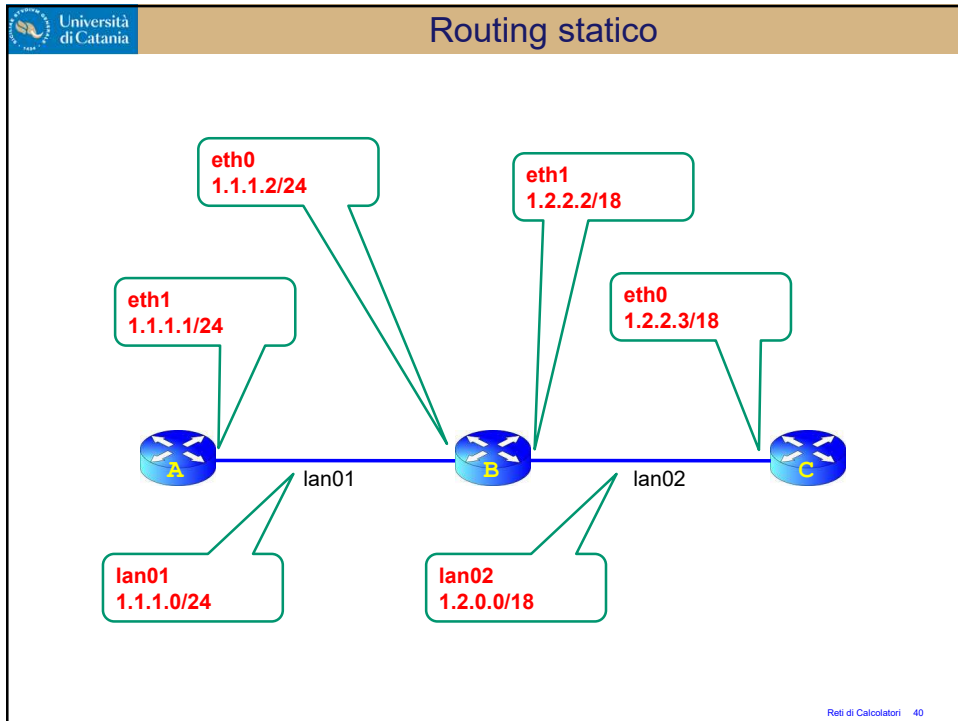
Inseriamo un router di uscita per la lan

```
enp0s3
IP address 1.1.1.1
Netmask 255.255.255.0
Gateway 1.1.1.254
```



```
ip addr 1.1.1.1/24 dev enp0s3
ip route add default via 1.1.1.254 dev enp0s3
```





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Routing statico

Aggiungere una regola di routing specifica

```
ip route add x.x.x.x/n via g.g.g.g
```

Nel nodo A

```
ip route add 1.2.0.0/18 via 1.1.1.2
```

Nel nodo C

```
ip route add 1.1.1.0/24 via 1.2.2.2
```

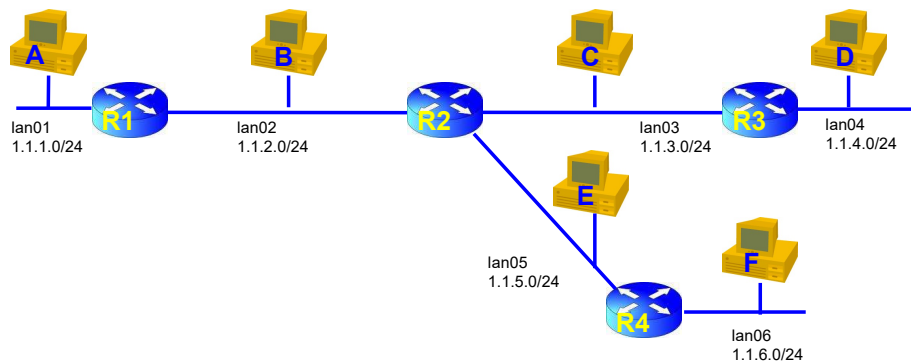
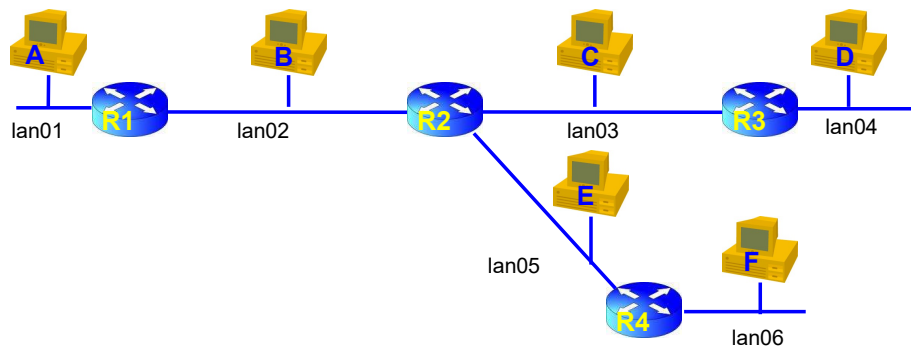
Per cancellare una entry

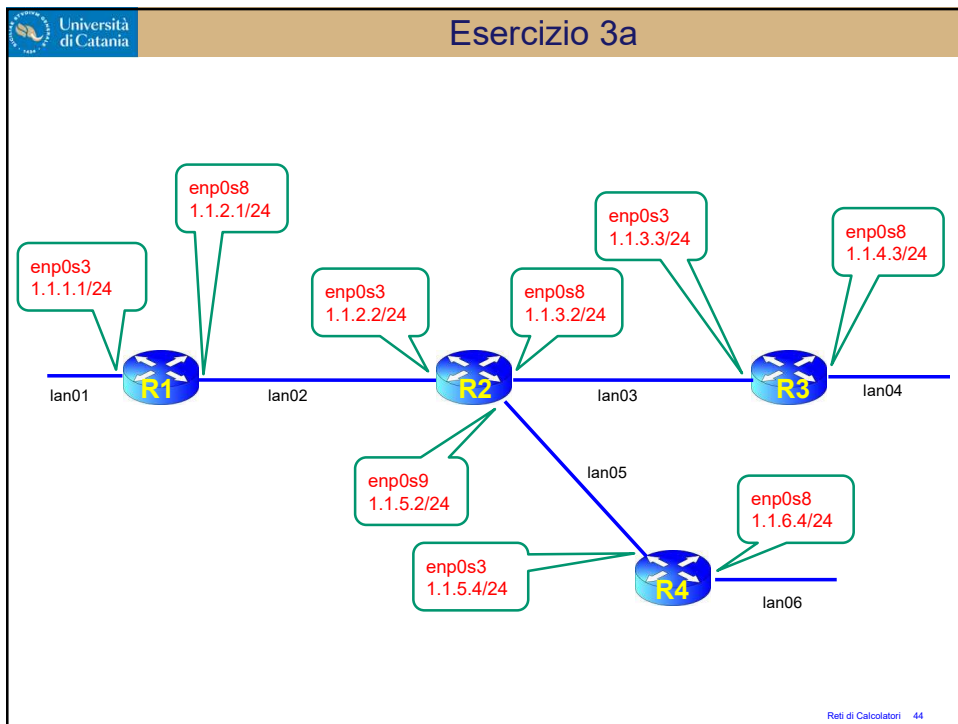
```
ip route delete x.x.x.x/n via g.g.g.g
```

Reti di Calcolatori 41

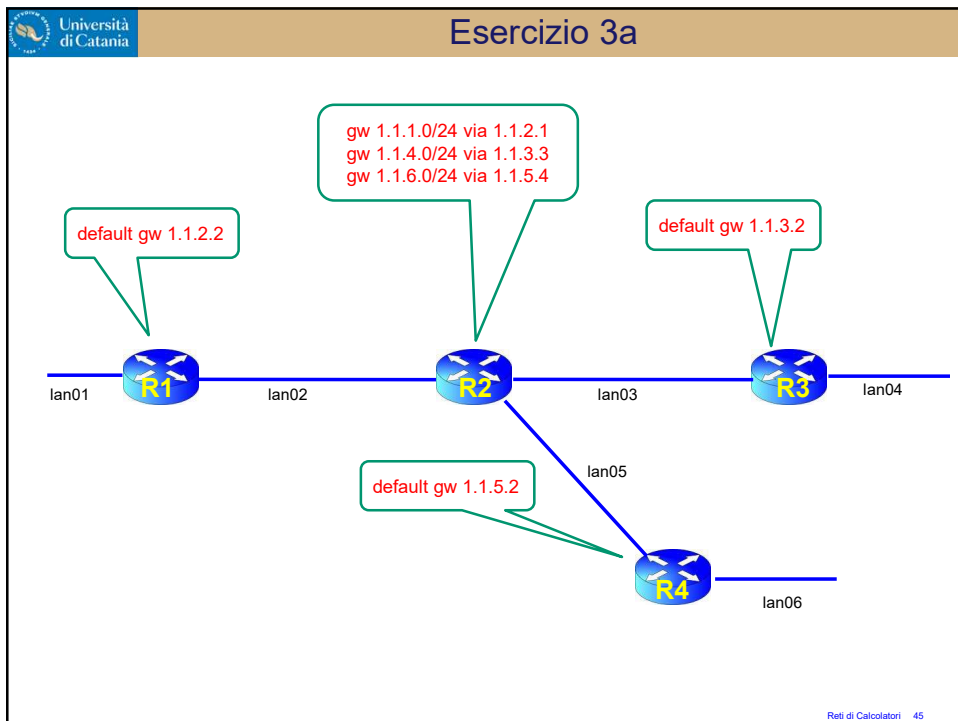
41

Configurare la seguente rete

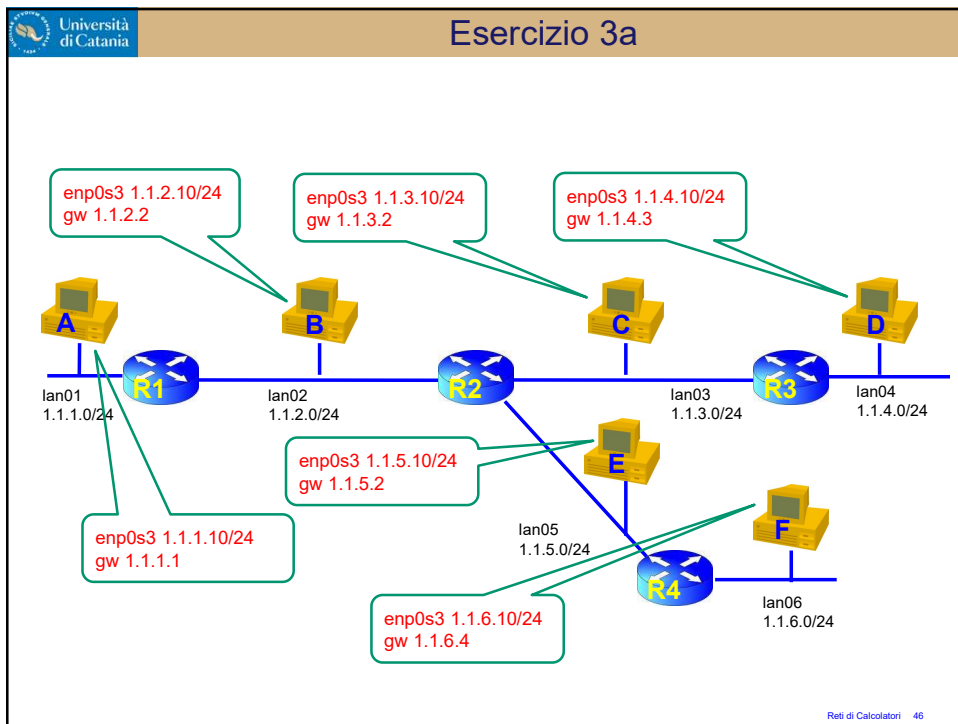




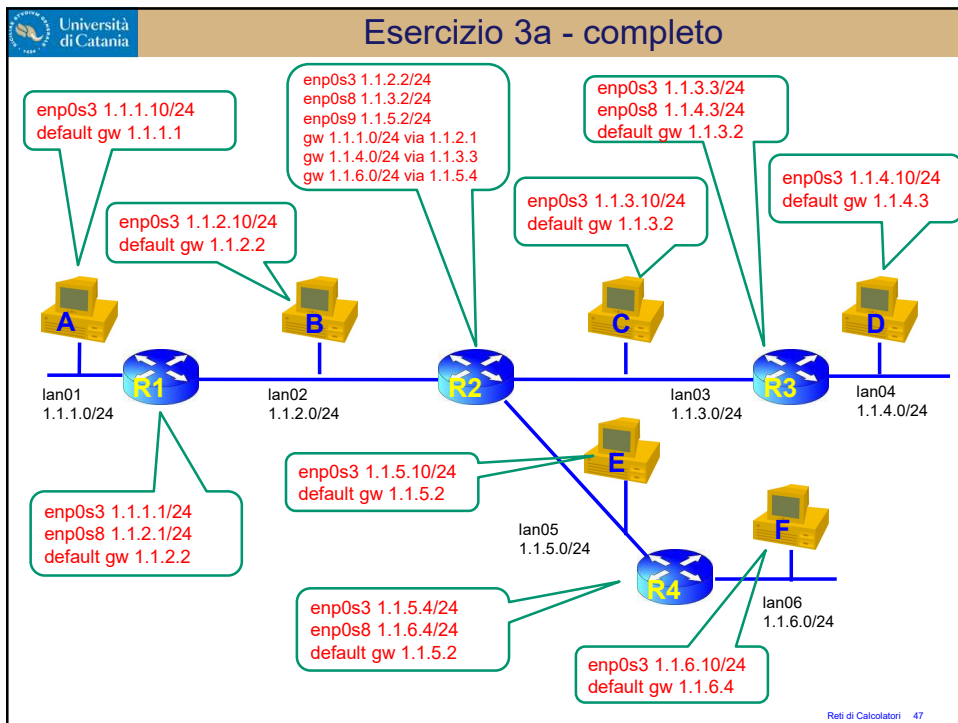
44



45



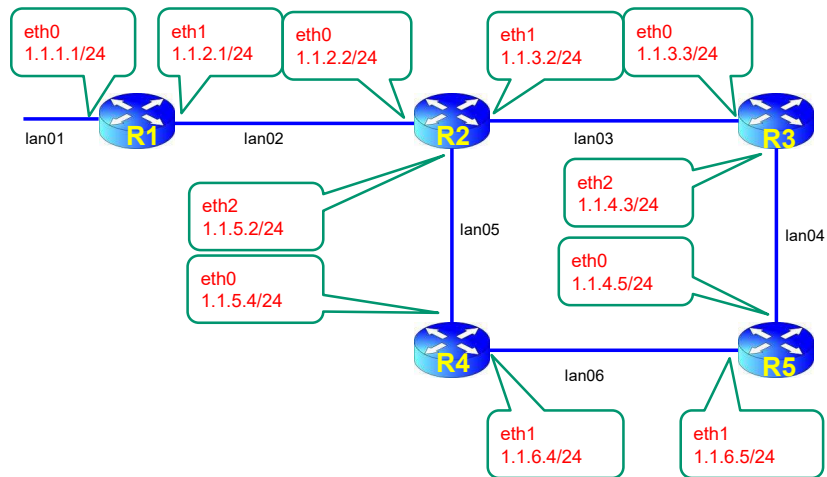
46



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Esercizio 3b

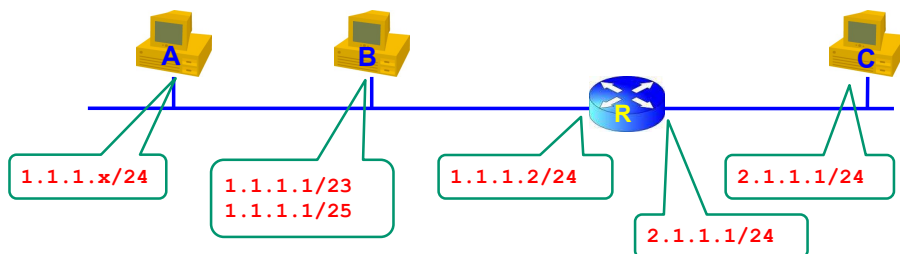
Configurare la seguente rete e verificarne il corretto funzionamento



48

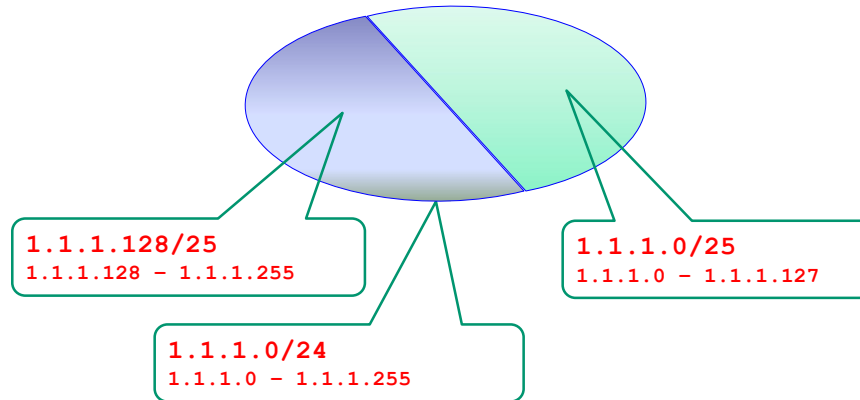
Esercizio 4

Un nodo in una lan ha la maschera di rete sbagliata. Descrivere teoricamente cosa può succedere nei vari scenari possibili. Successivamente verificare quanto detto.

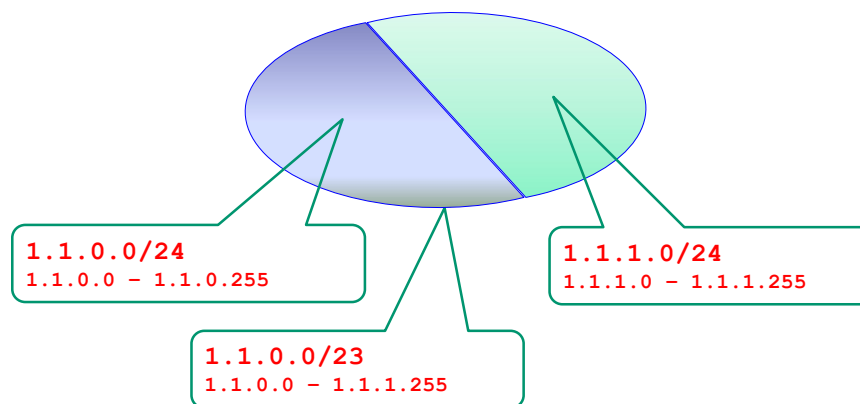


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Ipotesi 1: maschera più grande (24 -> 25)

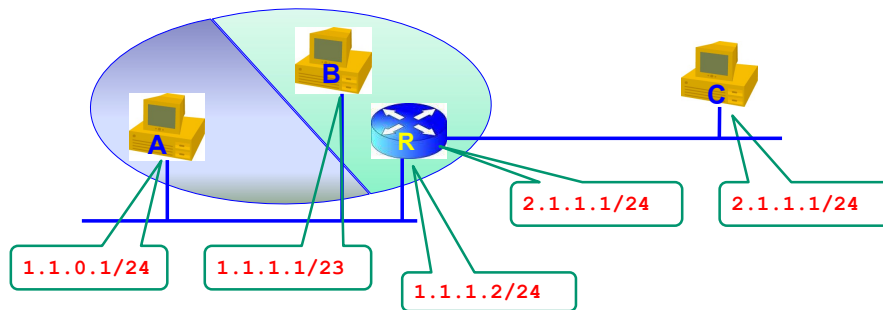


Ipotesi 2: maschera più piccola (24 -> 23)



Maschera più piccola (24 -> 23)

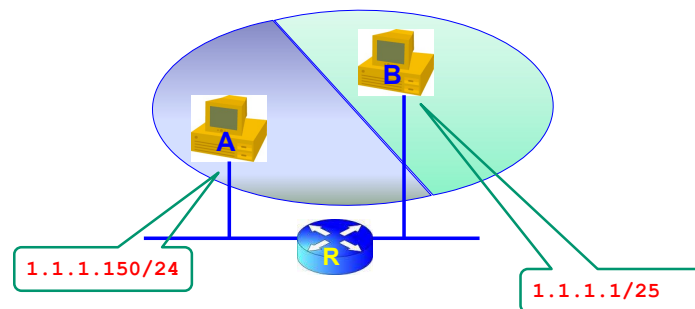
Rete vista dal nodo B



1.1.1.0/24 -> raggiungibile
1.1.0.0/24 -> irraggiungibile
Tutto il resto -> raggiungibile

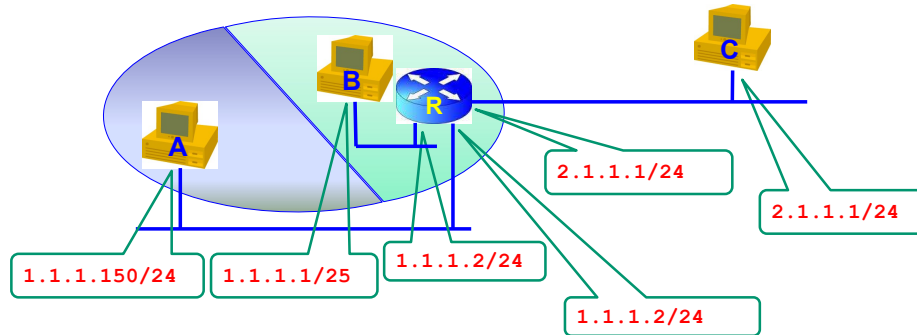
Maschera più grande (24 -> 25)

Rete vista dal nodo B



1.1.1.0/25 -> raggiungibile
Il nodo A vede il router R?

Rete vista dal nodo B



1.1.1.0/25 -> raggiungibile
 1.1.1.128/25 -> raggiungibile tramite il router
 Tutto il resto -> raggiungibile

```

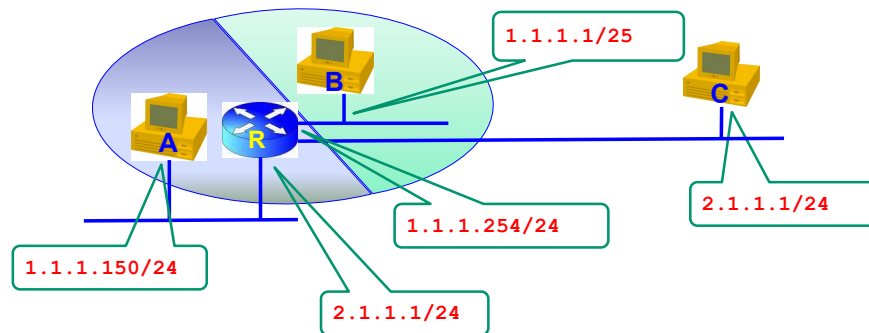
root@LabReti ~# ifconfig eth0
eth0: Link encap:Ethernet HWaddr 08:0c:29:fc:db:97
  inet addr:1.1.1.1 Bcast:1.1.1.127 Mask:255.255.255.128
  inet6 addr: fe80::20c:29ff:fe00:db97/64 Scope:Link
  UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
  RX packets:137 errors:0 dropped:0 overruns:0 frame:0
  TX packets:125 errors:0 dropped:0 overruns:0 carrier:0
  collisions:0 txqueuelen:1000
  RX bytes:13110 (12.8 KiB) TX bytes:9390 (9.1 KiB)
  Interrupt:19 Base address:0x2000

root@LabReti ~# ping -c 2 1.1.1.150
PING 1.1.1.150 (1.1.1.150) 56(84) bytes of data:
From 1.1.1.2: icmp_seq=1 Redirect Host(New nexthop: 1.1.1.150)
64 bytes from 1.1.1.150: icmp_seq=1 ttl=64 time=1.79 ms
From 1.1.1.2: icmp_seq=2 Redirect Host(New nexthop: 1.1.1.150)
64 bytes from 1.1.1.150: icmp_seq=2 ttl=64 time=1.54 ms

--- 1.1.1.150 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1003ms
rtt min/avg/max/mdev = 1.545/1.669/1.793/0.124 ms

root@LabReti ~# arp -a
? (1.1.1.150) at 08:0c:29:fc:db:97 [ether] on eth0
? (1.1.1.2) at 08:0c:29:78:ed:9a [ether] on eth0
root@LabReti ~#
    
```

Rete vista dal nodo B



Il nodo B non raggiunge il router R

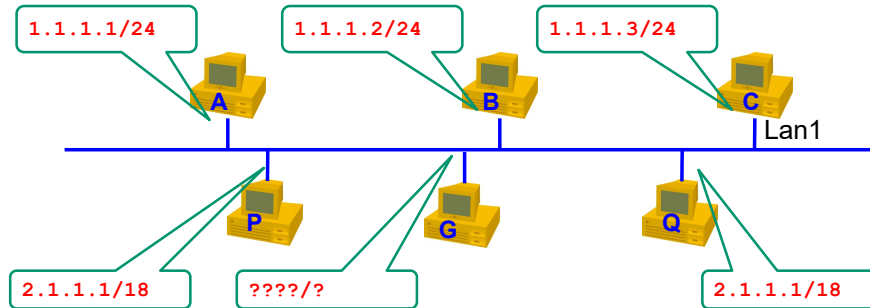
```

NodoA x  NodoB x  NodoC x  NodeR1 x  NodeR2 x  NodeR3 x
root@LabReti ~]# ifconfig eth0 1.1.1.1/25
root@LabReti ~]# ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 00:0C:29:A6:28:0C
          inet addr:1.1.1.1  Bcast:1.1.1.127  Mask:255.255.255.128
          inet6 addr: fe80::20c:29ff:fea6:280c/64  Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:12 errors:0 dropped:0 overruns:0 frame:0
          TX packets:30 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:896 (896.0 b)  TX bytes:1668 (1.6 KiB)
          Interrupt:19  Base address:0x2000

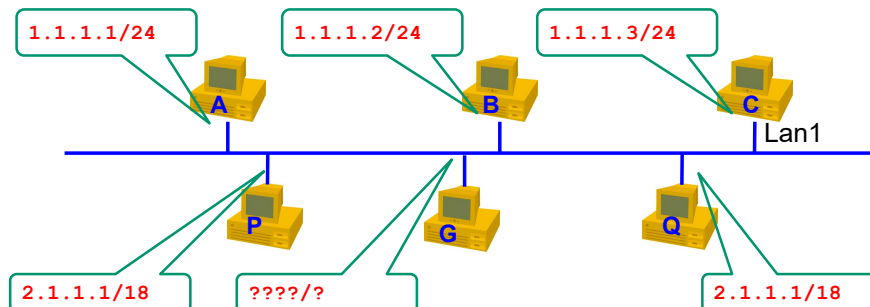
root@LabReti ~]# route add default gw 1.1.1.254
SIOCADDRT: No such process
root@LabReti ~]# _

```

Data la lan in figura (unica per tutti i nodi) configurare il nodo G in modo che gli altri nodi possano comunicare tra loro.



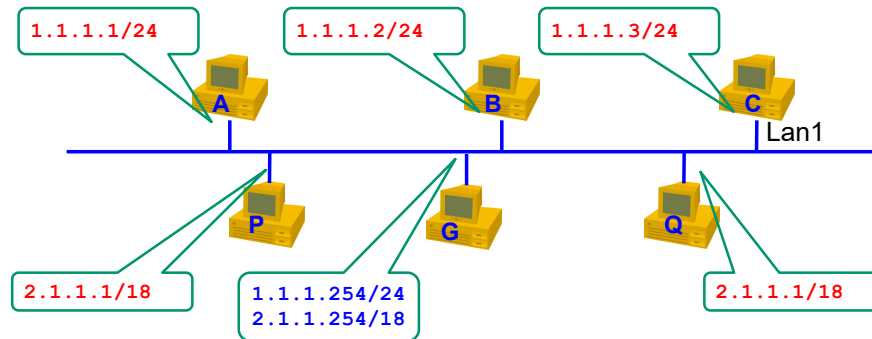
Tutti i nodi saranno configurati con un default GW della propria subnet



```
route add default gw 1.1.1.254 eth0
```

```
route add default gw 2.1.1.254 eth0
```

Il nodo G deve avere due indirizzi



È possibile creare una **virtual network interface** su una interfaccia reale.

```
# ifconfig eth0:0
eth0:0    Link encap:Ethernet  HWaddr 3c:97:0e:02:98:c8
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          Interrupt:20  Memory:f1600000-f1620000
```

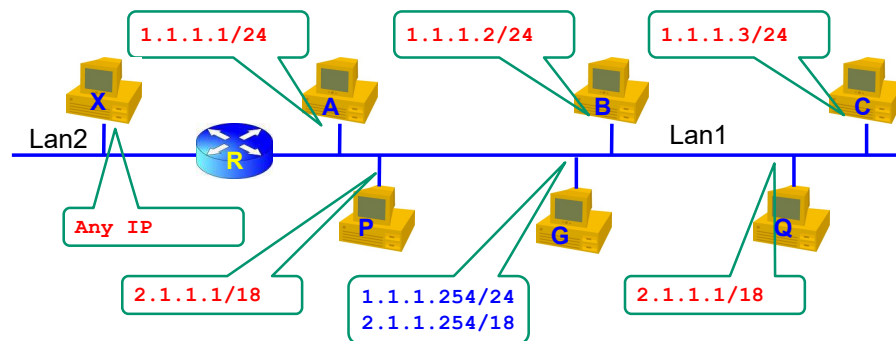
```
# ifconfig eth0:0 123.123.22.22/24
# ifconfig eth0:0
eth0:0    Link encap:Ethernet  HWaddr 3c:97:0e:02:98:c8
          inet addr:123.123.22.22  Bcast:123.123.22.255
          Mask:255.255.255.0
```

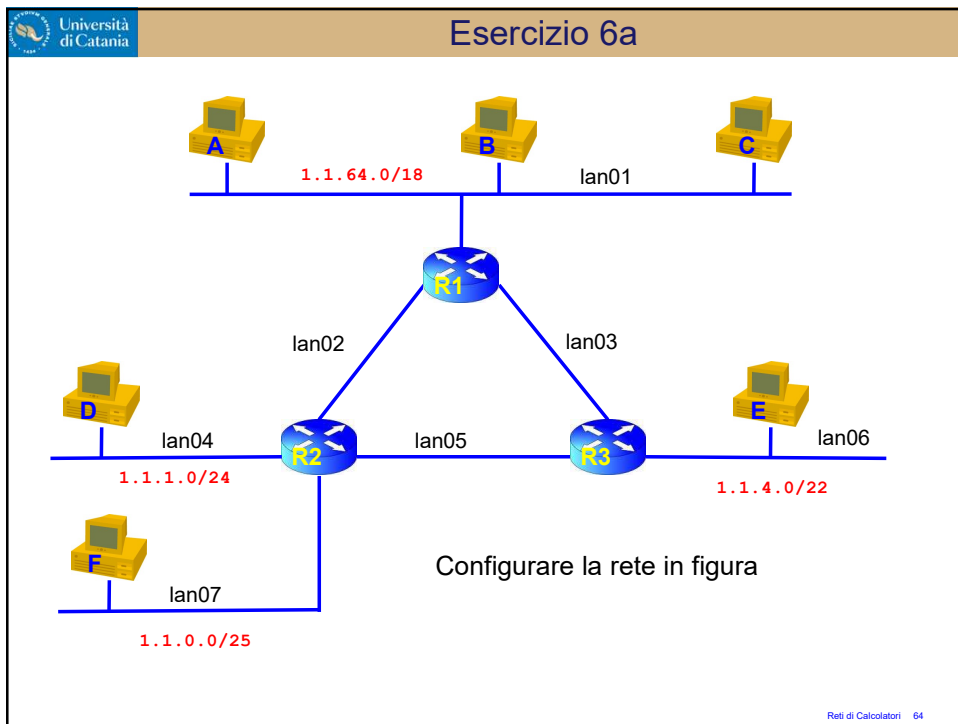
eth0:0 avrà lo stesso MAC address di **eth0**

```
[root@localhost ~]# ifconfig eth0:0 2.2.2.2/18
[root@localhost ~]# ifconfig
eth0      Link encap:Ethernet  HWaddr 08:00:27:32:B2:7B
          inet addr:1.1.1.1  Bcast:1.1.1.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe32:b27b/64  Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 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:0 (0.0 b)  TX bytes:468 (468.0 b)

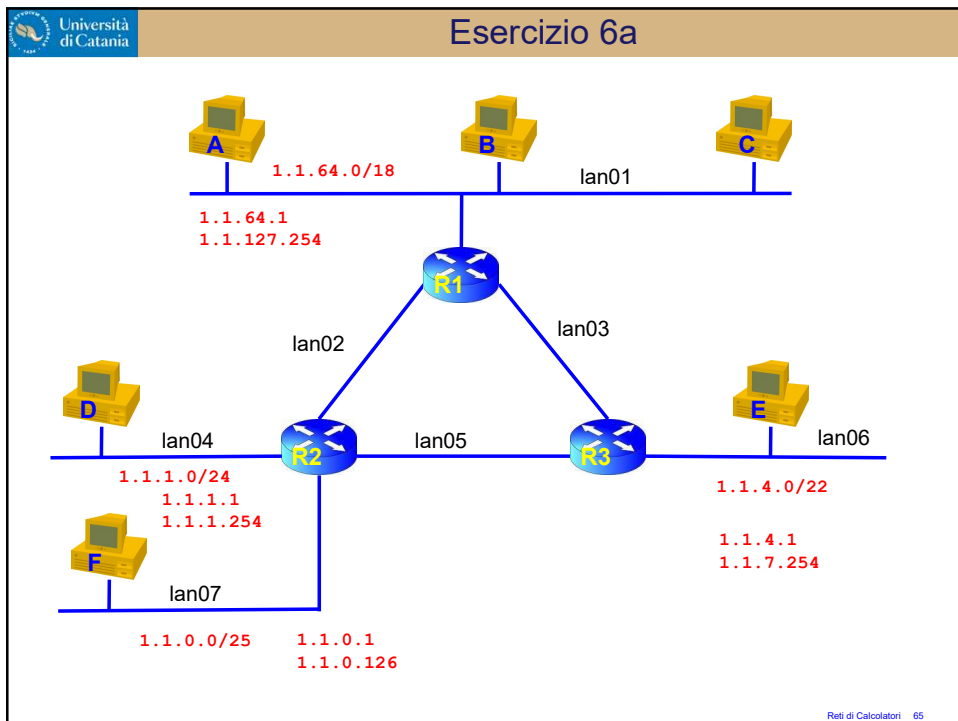
eth0:0    Link encap:Ethernet  HWaddr 08:00:27:32:B2:7B
          inet addr:2.2.2.2  Bcast:2.2.63.255  Mask:255.255.192.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
```

Aggiungere un collegamento verso il mondo esterno

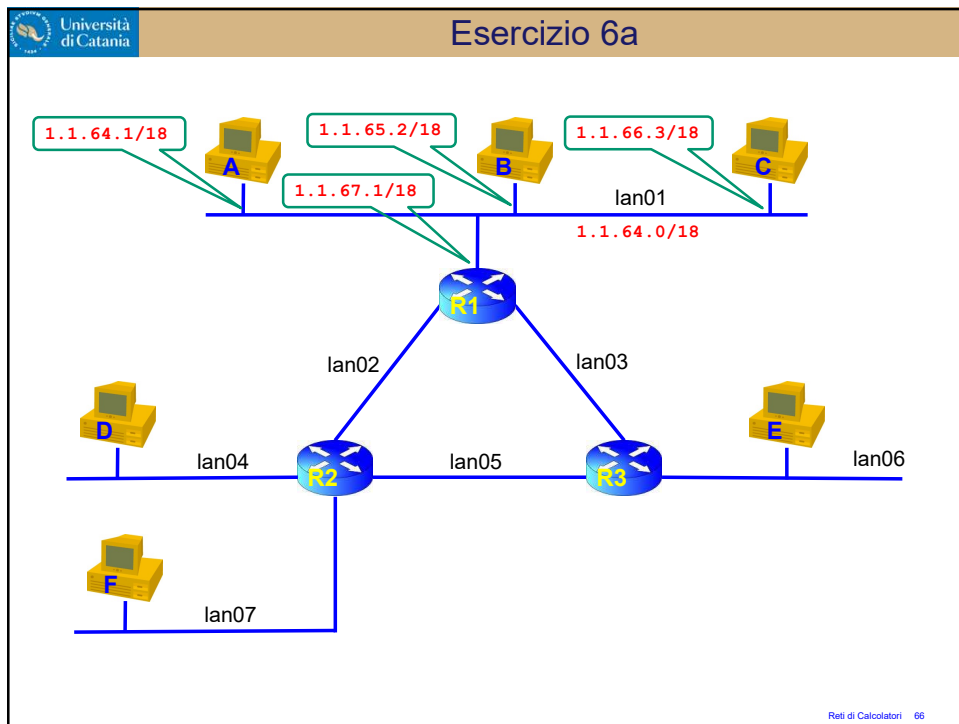




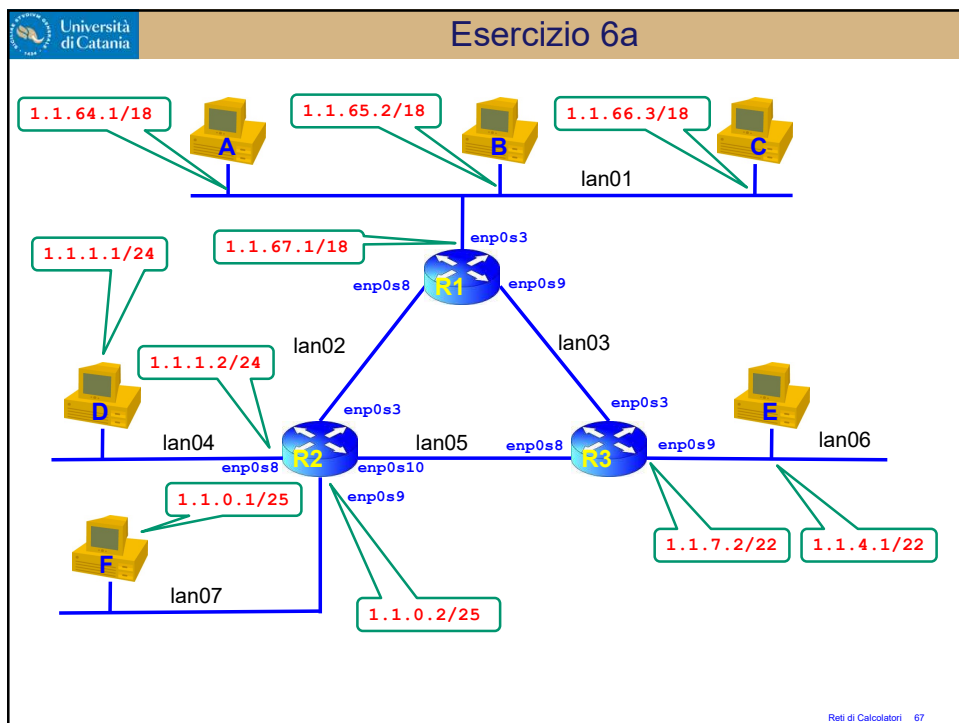
64



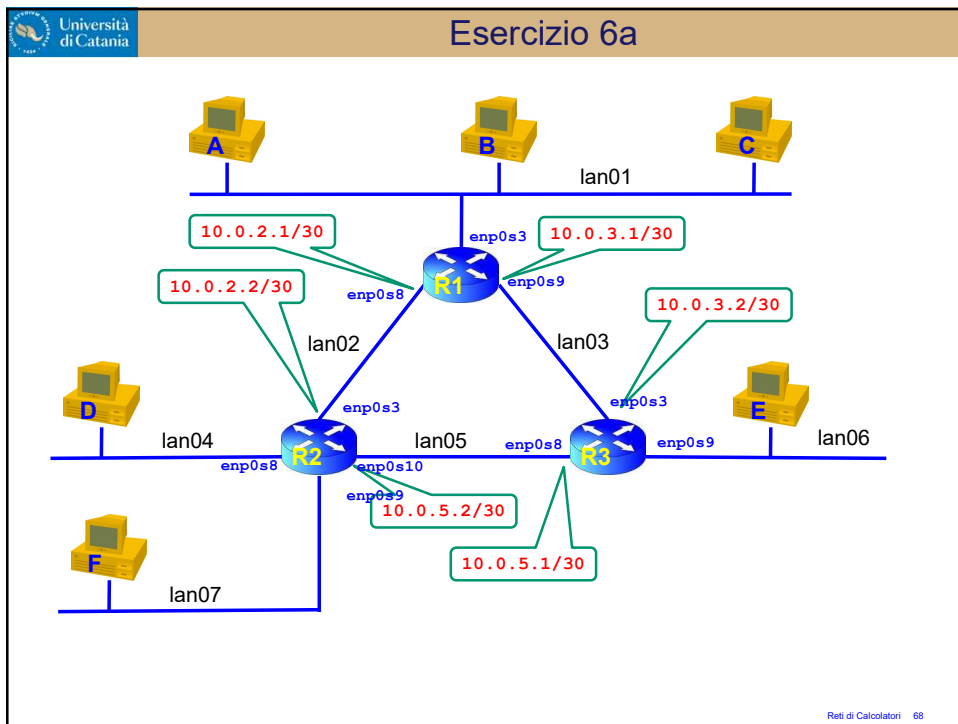
65



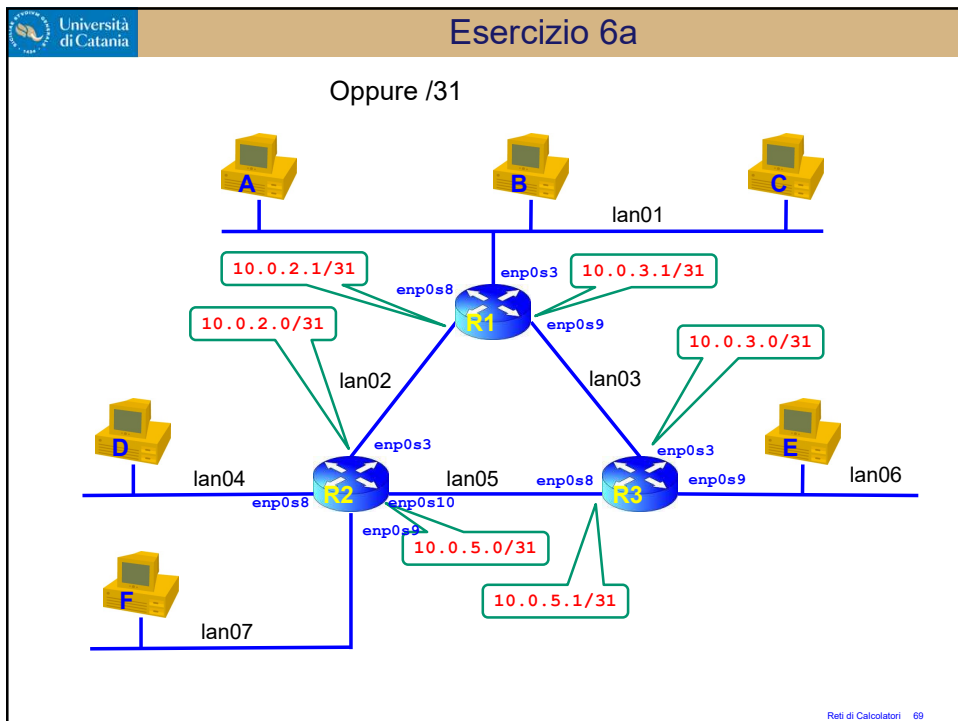
66



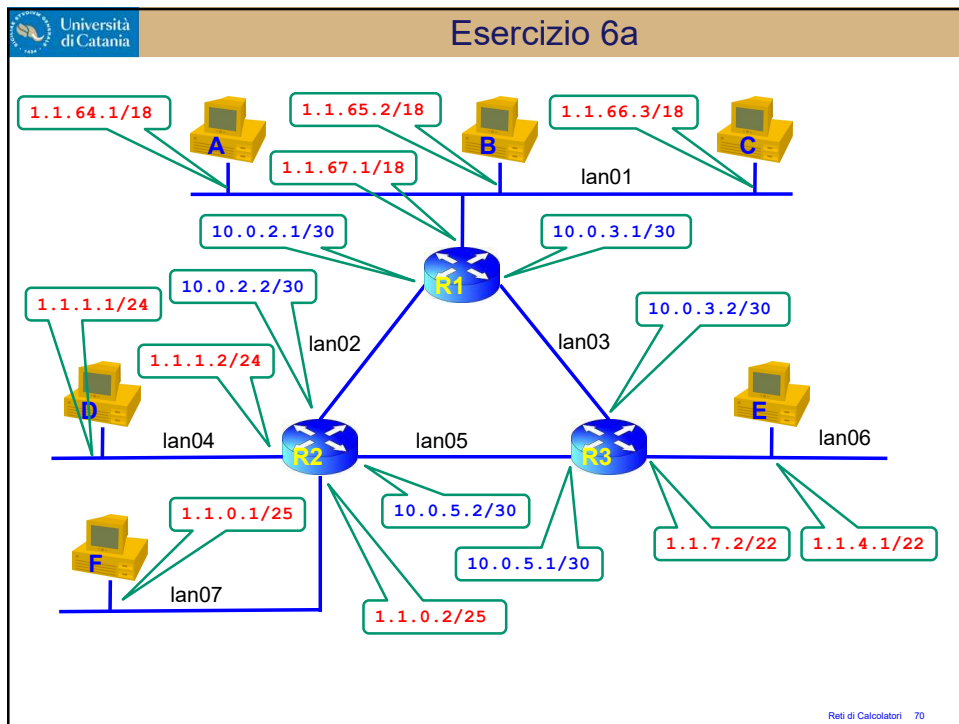
67



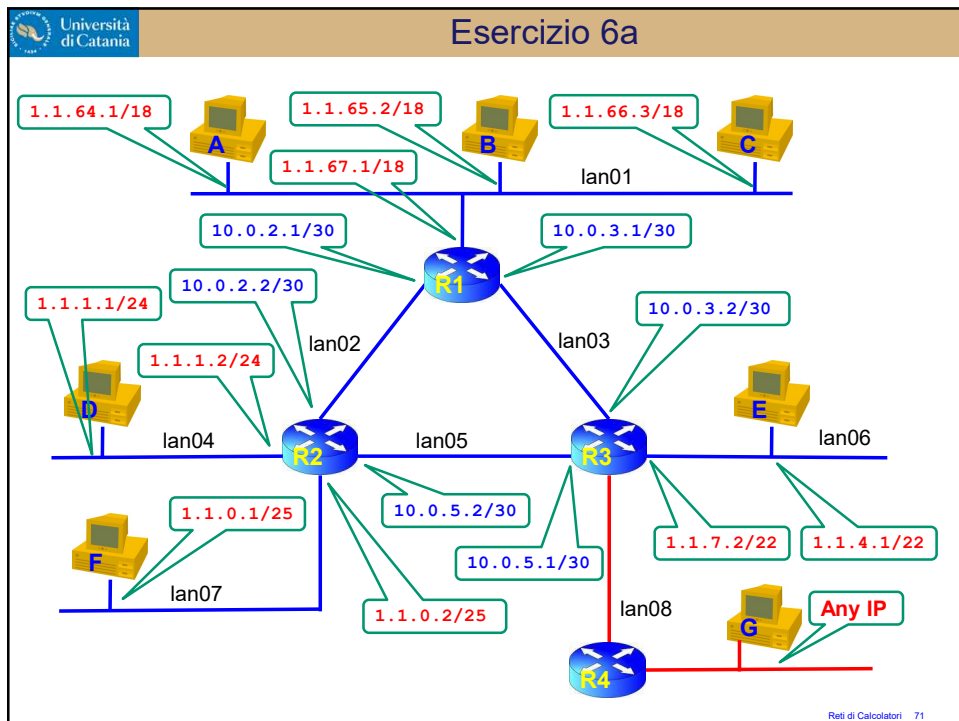
68



69



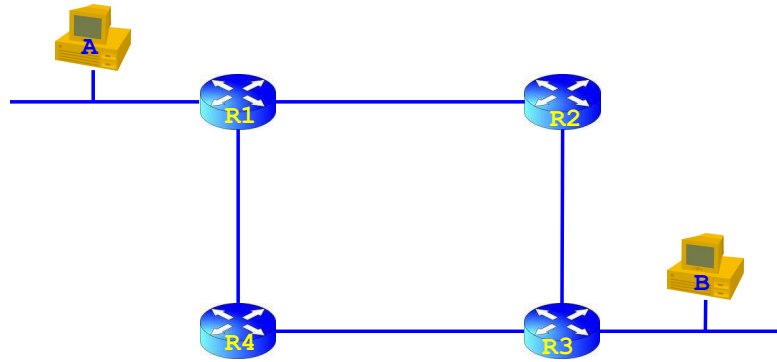
70



71

Esercizio 7

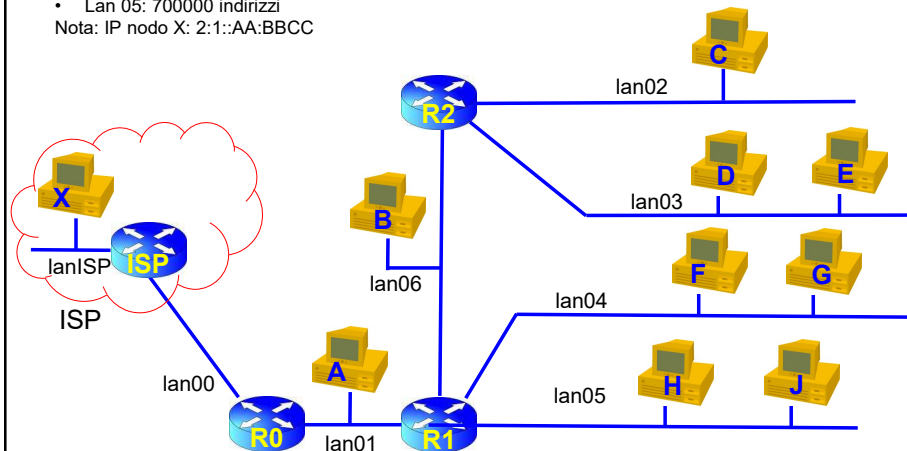
Configurare i router R1 R2 R3 R4 in modo che il traffico sui link tra loro sia unidirezionale (in senso orario)




Esercizio 8

La società FlatEarth inc. ha assegnati gli indirizzi IPv6 nel range 2:4::FFF0:0000:0000/96
Configurare host e router nel seguente schema, in modo da garantire eventuali espansioni future:

- Lan 02: 500000 indirizzi
 - Lan 03: 50000 indirizzi
 - Lan 04: 2500000 indirizzi
 - Lan 05: 700000 indirizzi
- Nota: IP nodo X: 2:1::AA:BBCC





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Esercizio 8

2:4::FFF0:0000:0000/96

Da 2:4::FFF0:0000:0000

A 2:4::FFF0:FFFF:FFFF

/96 2^32 = 4.294.967.296

/97 2^31 = 2.147.483.648

/98 2^30 = 1.073.741.824

..

/106 2^22 = 4.194.304 -> Lan 04 (2500000)

2:4::FFF0:0000:0000/106

Da 0002:0004:0000:0000:0000:fff0:0000:0000

A 0002:0004:0000:0000:0000:fff0:003F:FFFF

/108 2^20 = 1.048.576 -> Lan 05 (700000)

2:4::FFF0:0040:0000/108

Da 0002:0004:0000:0000:0000:fff0:0040:0000

A 0002:0004:0000:0000:0000:fff0:004F:FFFF

/109 2^19 = 524.288 -> Lan 02 (500000)

2:4::FFF0:0050:0000/109

Da 0002:0004:0000:0000:0000:fff0:0050:0000

A 0002:0004:0000:0000:0000:fff0:0057:FFFF


/112 2^16 = 65.536 -> Lan 03 (50000)

2:4::FFF0:0058:0000/112

Da 0002:0004:0000:0000:0000:fff0:0058:0000

A 0002:0004:0000:0000:0000:fff0:0058:FFFF

Reti di Calcolatori 74



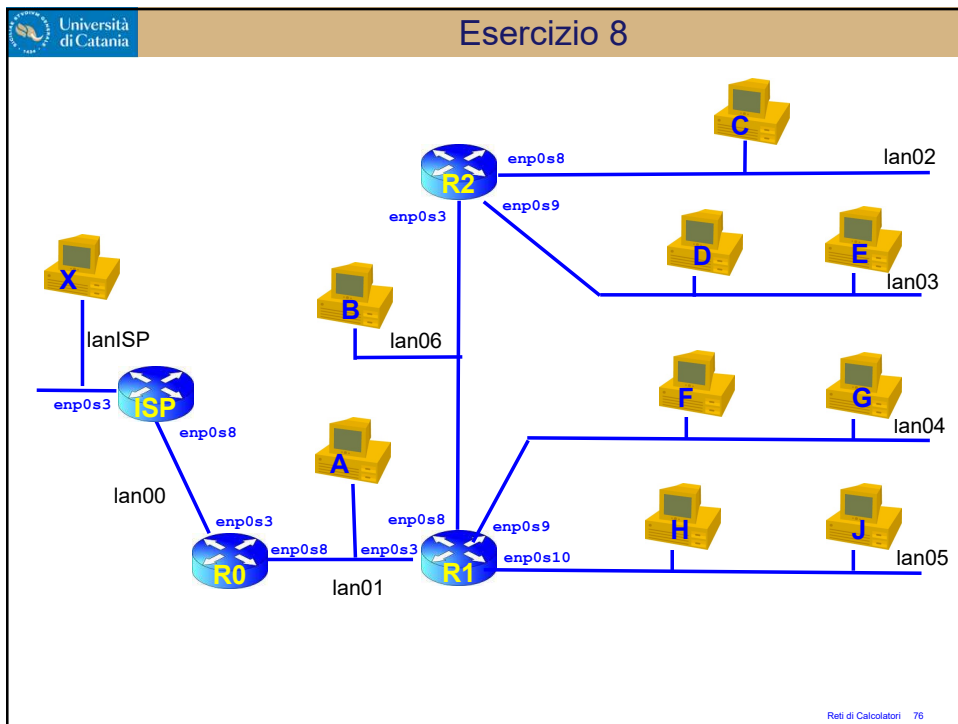
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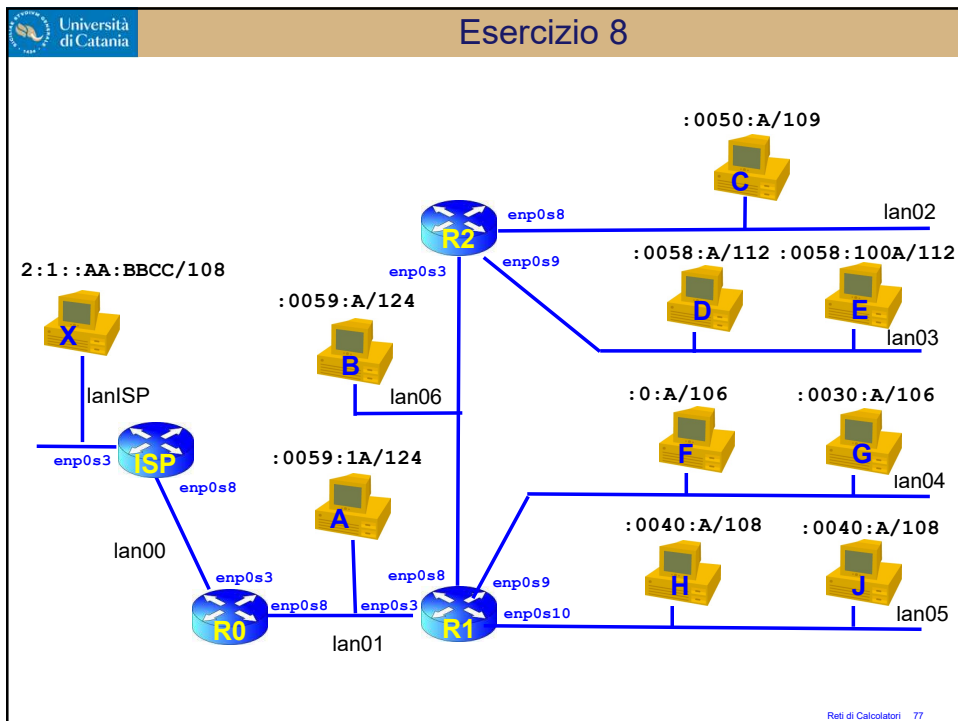
Esercizio 8

	Da	A	n°
2:4::FFF0:0000:0000/96	2:4::FFF0:0000:0000	2:4::FFF0:FFFF:FFFF	4.294.967.296
2:4::FFF0:0000:0000/106	2:4::FFF0:0000:0000	2:4::FFF0:003F:FFFF	4.194.304
2:4::FFF0:0040:0000/108	2:4::FFF0:0040:0000	2:4::FFF0:004F:FFFF	1.048.576
2:4::FFF0:0050:0000/109	2:4::FFF0:0050:0000	2:4::FFF0:0057:FFFF	524.288
2:4::FFF0:0058:0000/112	2:4::FFF0:0058:0000	2:4::FFF0:0058:FFFF	65536
2:4::FFF0:0059:0000/124	2:4::FFF0:0059:0000	2:4::FFF0:0059:000F	16
2:4::FFF0:0059:0010/124	2:4::FFF0:0059:0010	2:4::FFF0:0059:001F	16

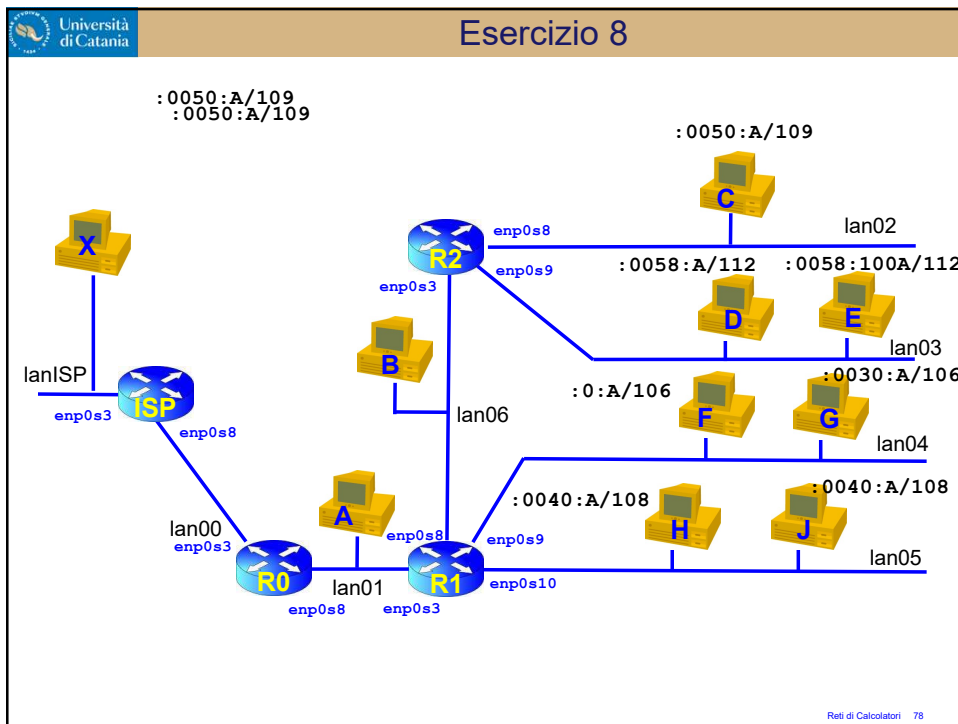
Reti di Calcolatori 75



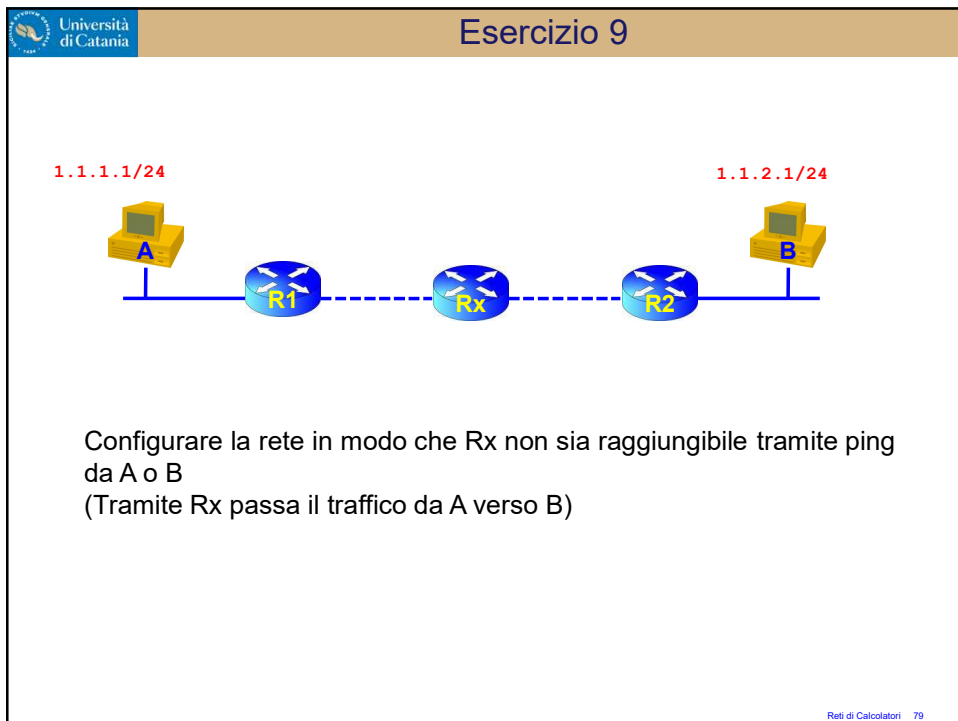
76



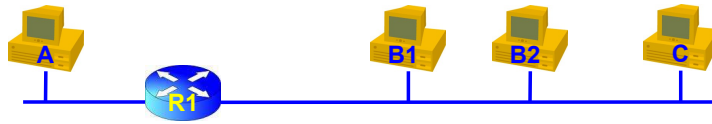
77



78



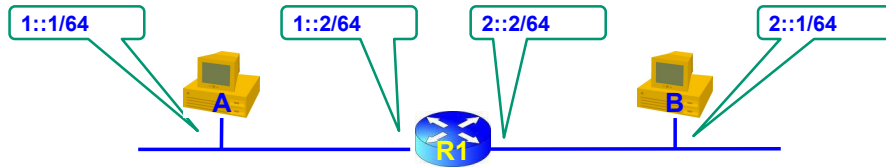
79



Configurare la rete in modo che, quando B1 è spenta, il traffico diretto a B1 vada in automatico a B2.



Configurare la rete utilizzando solo indirizzi IPv6



```
ip addr add 1::1/64 dev enp0s3
```

```
ping6 2::1
```