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Laboratorio di Reti di Calcolatori

Destination	Gateway	Genmask	Flags	Iface
loopback	*	255.255.0.0	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



Reti di Calcolatori 1

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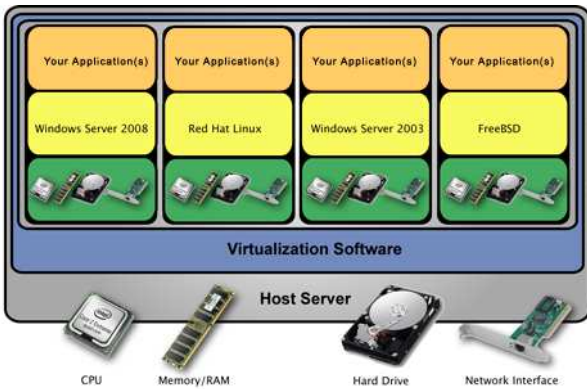
Laboratorio di Reti di Calcolatori



Reti di Calcolatori 2

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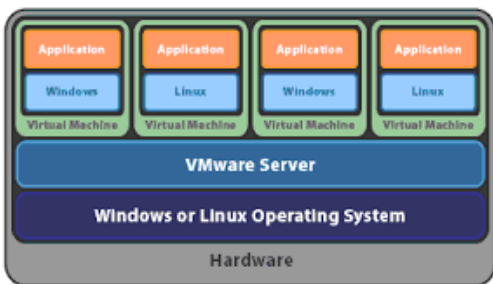
Virtualizzazione



Reti di Calcolatori 3

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Virtualizzazione



Reti di Calcolatori 4

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Virtualizzazione



Reti di Calcolatori 5

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Laboratorio di Reti di Calcolatori

Debian 9


Requisiti per l'installazione:

- RAM 1GB
- HD 2GB

Dopo l'installazione:

- RAM 256 (128) MB
- HD 800MB

Reti di Calcolatori 6



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Consistent Network Device Naming

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

Reti di Calcolatori 7



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ethx

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.

Reti di Calcolatori 8



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70-persistent-net.rules


```

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"

```

Reti di Calcolatori 9



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ifconfig vs ip

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)

Reti di Calcolatori 10



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ip addr


ip addr
Show information for all addresses

ip addr show dev em1
Display information only for device em1ip addr

ip addr add 192.168.1.1/24 dev em1
Add address 192.168.1.1 with netmask 24 to device em1

ip addr del 192.168.1.1/24 dev em1
Remove address 192.168.1.1/24 from device em1

Reti di Calcolatori 11



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ip route

ip route
List all of the route entries in the kernel


ip route add default via 192.168.1.1 dev em1
Add a default route (for all addresses) via the local gateway 192.168.1.1 that can be reached on device em1

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 em1
Replace the defined route for 192.168.1.0/24 to use device em1

Reti di Calcolatori 12



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ip neigh

ip neigh
Display neighbour objects


ip neigh show dev em1
Show the ARP cache for device em1

ip neigh add 192.168.1.1 lladdr 1:2:3:4:5:6 dev em1
Add address 192.168.1.1 with MAC 1:2:3:4:5:6 to em1

ip neigh del 192.168.1.1 dev em1
Invalidate the entry for 192.168.1.1 on em1

ip neigh replace 192.168.1.1 lladdr 1:2:3:4:5:6 dev em1
Replace the entry for address 192.168.1.1 to use MAC 1:2:3:4:5:6 on em1

Reti di Calcolatori - 13



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ip neigh

ip neigh
Display neighbour objects


ip neigh show dev em1
Show the ARP cache for device em1

ip neigh add 192.168.1.1 lladdr 1:2:3:4:5:6 dev em1
Add address 192.168.1.1 with MAC 1:2:3:4:5:6 to em1

ip neigh del 192.168.1.1 dev em1
Invalidate the entry for 192.168.1.1 on em1

ip neigh replace 192.168.1.1 lladdr 1:2:3:4:5:6 dev em1
Replace the entry for address 192.168.1.1 to use MAC 1:2:3:4:5:6 on em1

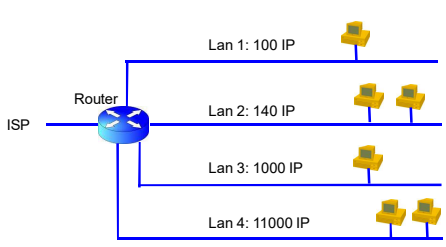
Reti di Calcolatori - 14



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Esercizio 1

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)

Reti di Calcolatori - 15




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Esercizio 1 - soluzione

145.67.0.0/16

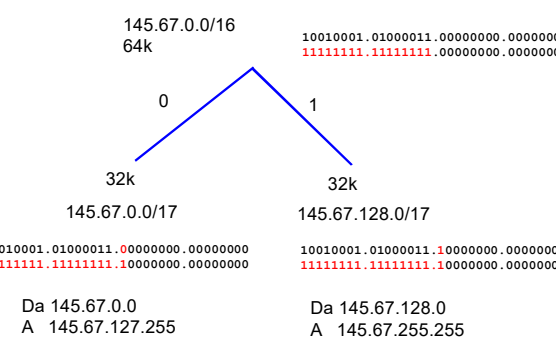
145.67.0.0 = 10010001.01000011.00000000.00000000
255.255.0.0 = 11111111.11111111.00000000.00000000

Reti di Calcolatori - 16



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Esercizio 1 - soluzione



Da 145.67.0.0
A 145.67.127.255

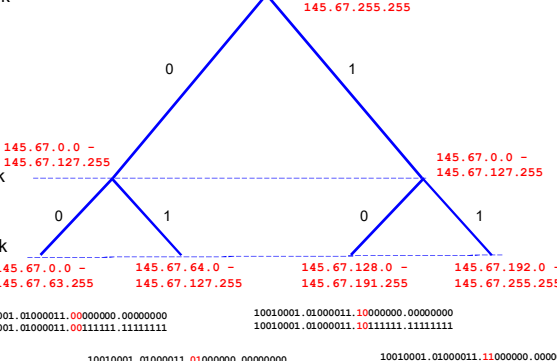
Da 145.67.128.0
A 145.67.255.255

Reti di Calcolatori - 17



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Esercizio 1 - soluzione



145.67.0.0 - 145.67.127.255

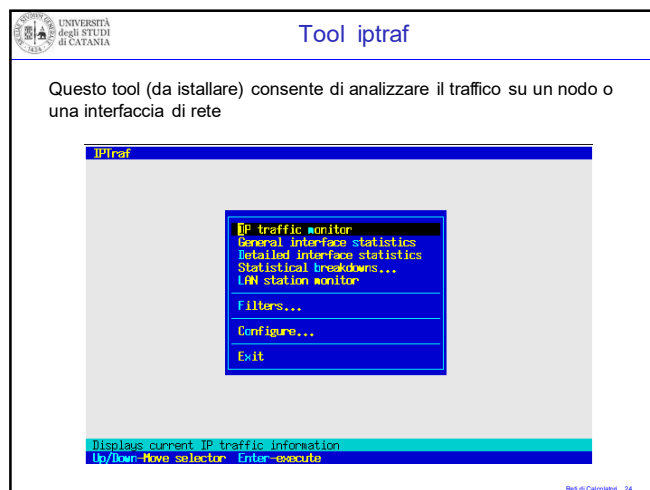
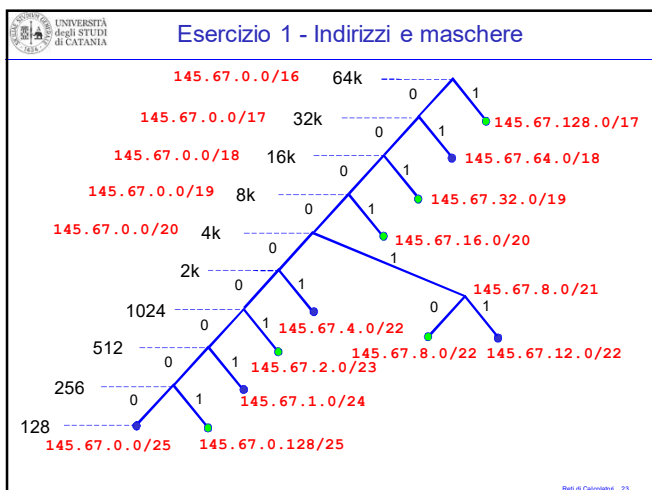
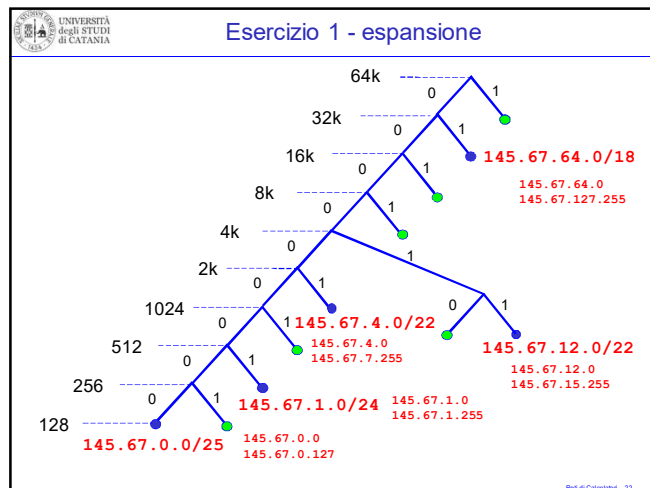
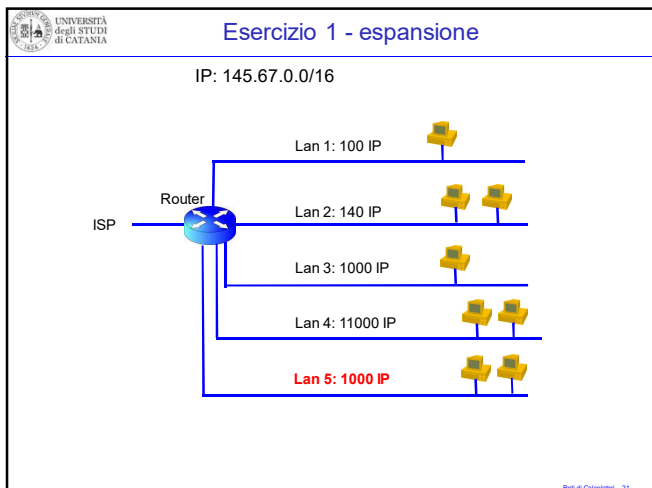
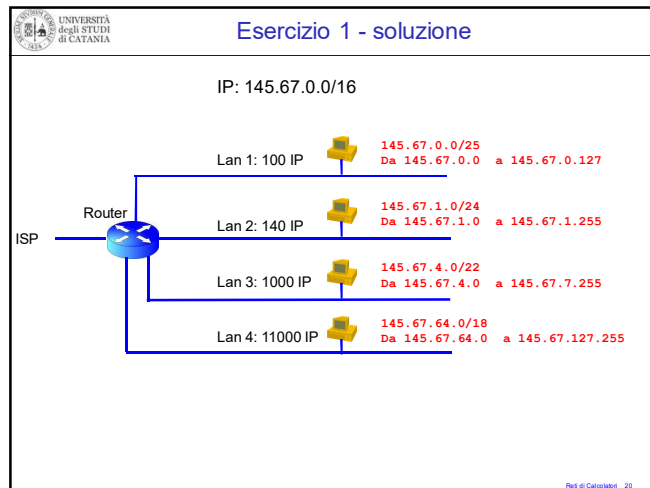
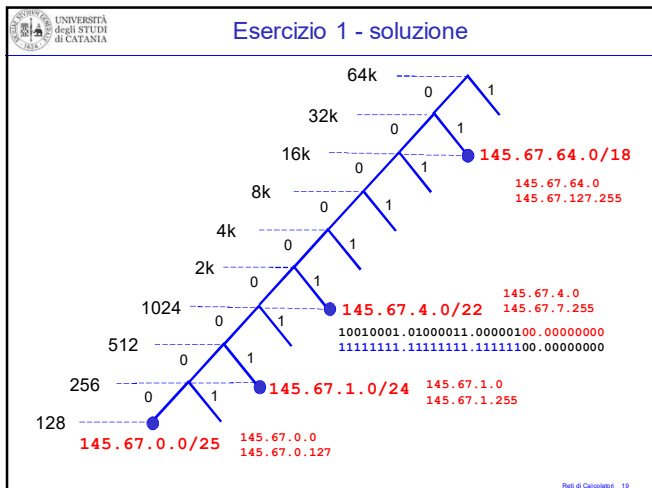
145.67.0.0 - 145.67.63.255

145.67.64.0 - 145.67.127.255

145.67.128.0 - 145.67.191.255

145.67.192.0 - 145.67.255.255

Reti di Calcolatori - 18



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iptraf

IPtraf

Reverse DNS lookups: On
 Force promiscuous mode: On
 Color: On
 Logging: Off
 Activity mode: kbits/s
 Source MAC address in traffic monitor: Off

Filters...
 Additional ports...
 Delete port/range...
 Ethernet/ATM IP host descriptions...
 FDDI/Token Ring host descriptions...
 Exit configuration

Resolves resolution of IP addresses into host names
 Up/Down-Menu selector Enter-execute

Red di Calabrese 25

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iptraf

IPtraf

IP traffic monitor
 General interface statistics
 Filter Status
 TCP... No TCP filter applied
 UDP... All UDP visible
 Other IP... No misc IP filter applied
 ARP ARP not visible
 RARP RARP visible
 Non-IP Non-IP not visible
 Exit Exit menu

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-Menu selector Enter-execute

Red di Calabrese 26

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iptraf

IPtraf

TCP Connections (Source Host:Port)	Packets	Bytes	Flags	Iface
61.9.80.40:3812	757	34822	-A-	eth0
61.9.4.185:http	1091	1501198	-P-	eth0
61.9.80.38:1624	528	24864	-A-	eth0
CPE3439373939323531.cpe.net.cabl:1214	832	1245048	-A-	eth0
boh141zou4111.bc.hsia.telus.net:1214	1139	1704236	-A-	eth0
61.9.80.38:1334	652	30798	-A-	eth0
64.94.89.245:http	533	760216	-P-	eth0
61.9.82.125:62620	346	18567	-A-	eth0
61.9.82.125:63612	277	13146	-A-	eth0
128.167.58.181:http	467	709508	-A-	eth0
61.9.82.122:64399	231	11070	-A-	eth0
h24-80-94-122.un.shaucaable.net:1214	332	496592	-P-	eth0

TCP: 6276 entries Active

ARP request for 61.9.108.253 (46 bytes) from 00d0b7b7ea8d to 00000c4340a0 on eth0
 ARP reply from 61.9.108.253 (46 bytes) from 00000c4340a0 to 00d0b7b7ea8d on eth0
 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 00d0b7b7ea8d to 0100c2000000 on eth0
 Non-IP (0x4) (46 bytes) from 00d0b7b7ea8d to 0100c2000000 on eth0
 Bottom Elapsed time: 0:03
 Pkts captured (all interfaces): 200029 TCP flow rate: 148.40 kbits/s
 Up/Dn/PgUp/PgDn-scroll H-more TCP info U-chg actv win S-sort TCP X-exit

Red di Calabrese 27

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iptraf

IPtraf

Ethernet	HW addr:	PktsIn	IP In	BytesIn	InRate	PktsOut	IP Out	BytesOut	OutRate
Ethernet	HW addr: 0050d6c010e8 on eth0	90	90	6401	0.0	128	127	8530	0.0
Ethernet	HW addr: 0030f2121000 on eth0	155	155	2838	0.0	163	141	15589	2.0
Ethernet	HW addr: 010056000005 on eth0	75	75	11482	2.4	0	0	0	0.0
Ethernet	HW addr: 00d0b7b7ea8d on eth0	0	0	0	0.0	0	0	0	0.0
Ethernet	HW addr: 0180c2000000 on eth0	18	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: 0000b7b7ea8d 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: 0050f33f3021 on eth0	0	0	0	0.0	4	0	240	0.0
Ethernet	HW addr: 0030f4152f01 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/Dn/PgUp/PgDn-scroll window S-sort X-exit

Red di Calabrese 28

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IPv4 forwarding

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`

Red di Calabrese 29

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ip addr

```
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
```

Red di Calabrese 30

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ip route

```
#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
```

Reti di Calcolatori 31

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routing

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

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
```

Reti di Calcolatori 32

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Esercizio 2a

Cosa succede in questa rete? Verificare sperimentalmente

Reti di Calcolatori 33

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Esercizio 2b

Cambiamo la maschera del nodo B. Cosa succede?

Reti di Calcolatori 34

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Modalità promiscua

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
```

Reti di Calcolatori 35

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Router

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
```

Reti di Calcolatori 36

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Gateway di default

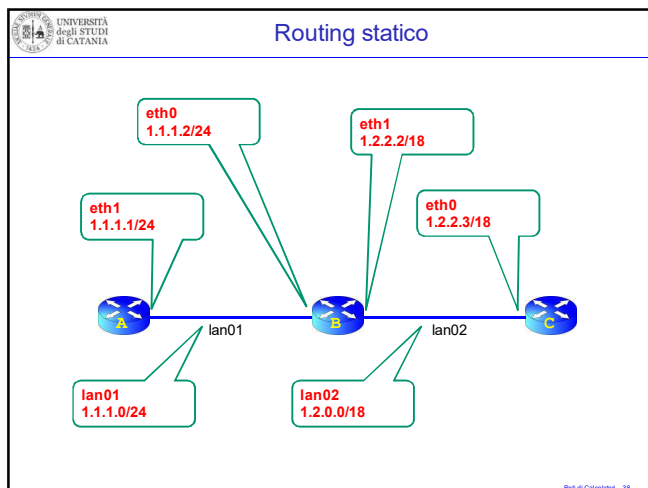
```
ip addr 1.1.1.1/24 dev enp0s3
ip route add default via 1.1.1.254 dev enp0s3
```

enp0s3 1.1.1.1/24

enp0s3 1.1.1.254/24

Lan 1.1.1.0/24

Reti di Calcolatori 37



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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
```

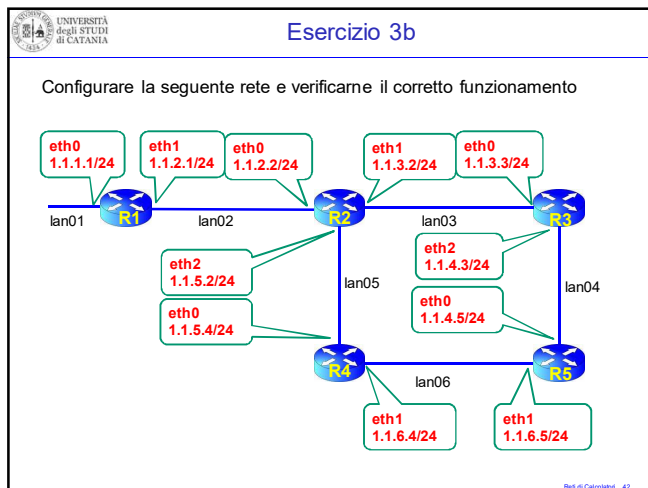
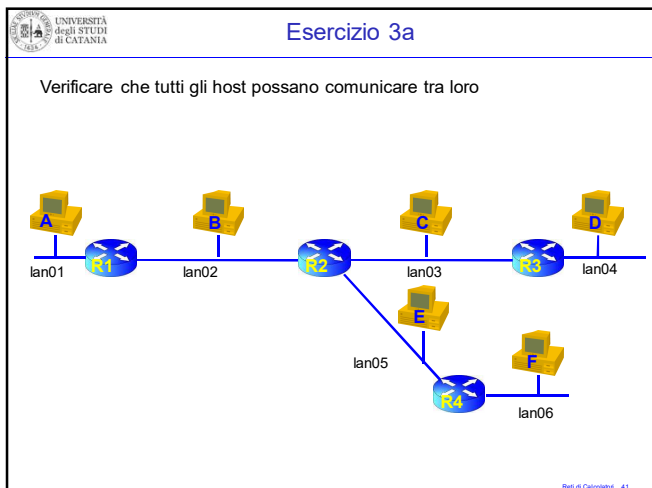
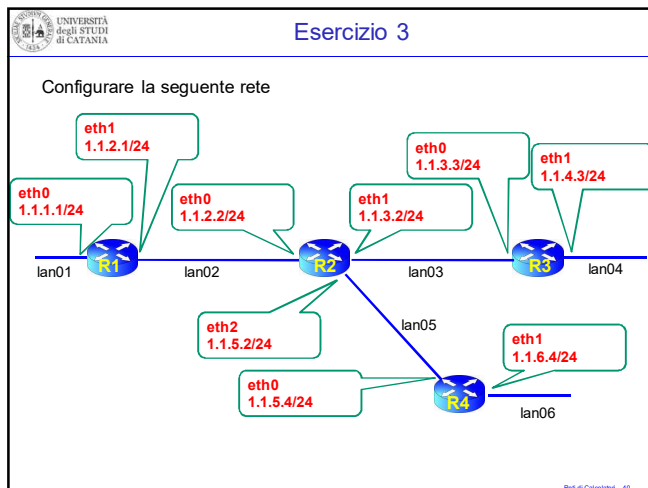
Nel nodo C

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

Per cancellare una entry

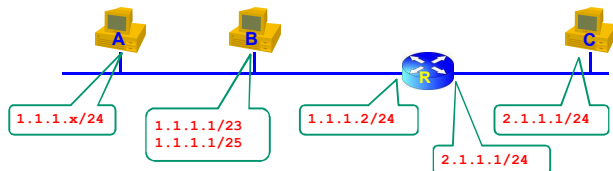
```
ip route delete x.x.x.x/n via g.g.g.g
```

Reti di Calcolatori 39

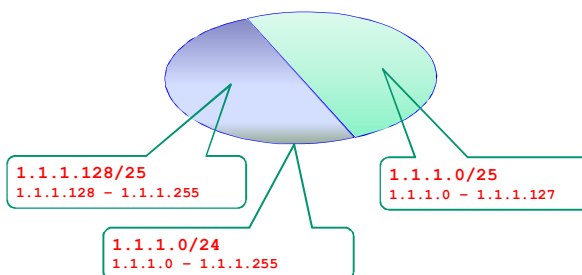


Esercizio 4

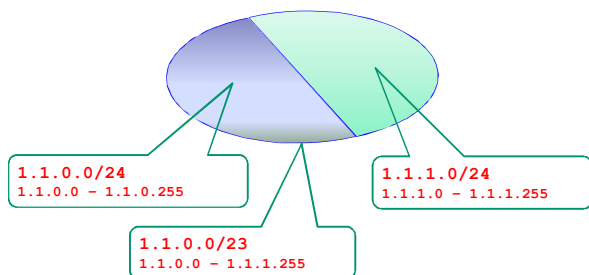
Un nodo in una lan ha la maschera di rete sbagliata. Descrivere teoricamente cosa può succedere nei vari scenari possibili. Successivamente verificare quanto detto.



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

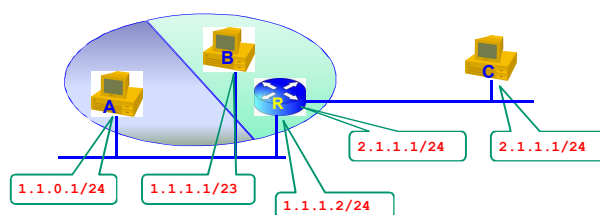


Ipotesi 2: maschera più piccola (24 -> 23)



Maschera più piccola (24 -> 23)

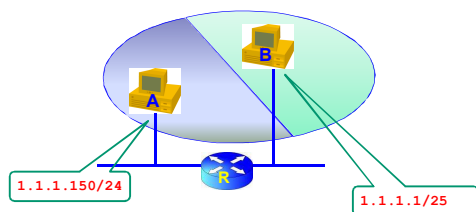
Rete vista dal nodo B



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

Maschera più grande (24 -> 25)

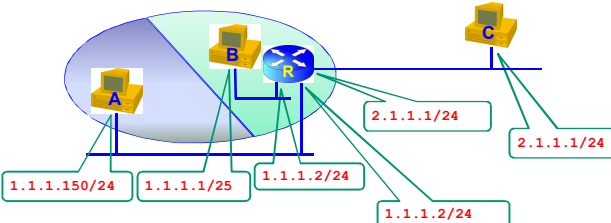
Rete vista dal nodo B



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

Maschera più grande (24 -> 25)

Rete vista dal nodo B



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

Maschera più grande (24 -> 25)

```

root@LabReti:~# ifconfig eth0
eth0: flags=4096<UP,BROADCAST,RUNNING,MULTICAST> mtu=1500
    inet addr:1.1.1.1 Bcast:1.1.1.127 Mask:255.255.255.128
    link encap:Ethernet HWaddr 08:0C:29:A6:28:0C
    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
root@LabReti:~#
  
```

Press Ctrl+G.

Maschera più grande (24 -> 25)

Rete vista dal nodo B

Il nodo B non raggiunge il router R

Maschera più grande (24 -> 25)

```

root@LabReti:~# ifconfig eth0 1.1.1.1/25
eth0: flags=4096<UP,BROADCAST,RUNNING,MULTICAST> mtu=1500
    inet addr:1.1.1.1 Bcast:1.1.1.127 Mask:255.255.255.128
    link encap:Ethernet HWaddr 08:0C:29:A6:28:0C
    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:1660 (1.6 KiB)
    Interrupt:19 Base address:0x2000

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

Press Ctrl+G.

Esercizio 5a

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

Esercizio 5a

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
  
```

Esercizio 5a

Il nodo G deve avere due indirizzi

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Virtual network interfaces

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
```

Reti di Calcolatori 55

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Virtual network interfaces

```
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
```

Reti di Calcolatori 55

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Esercizio 5b

Aggiungere un collegamento verso il mondo esterno

Reti di Calcolatori 57

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Esercizio 6a

Configurare la rete in figura

Reti di Calcolatori 58

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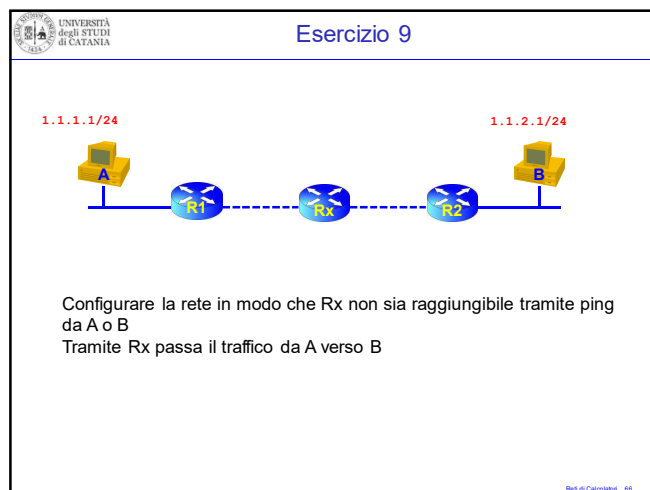
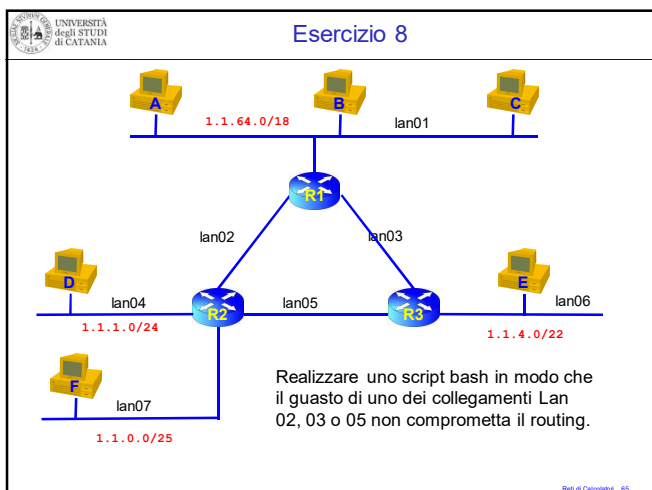
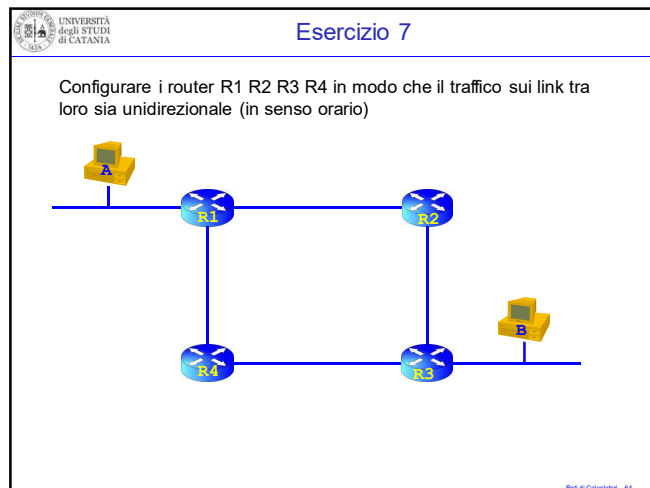
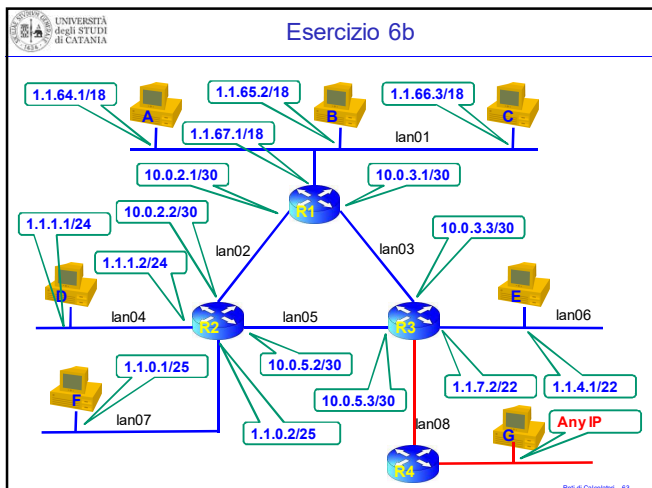
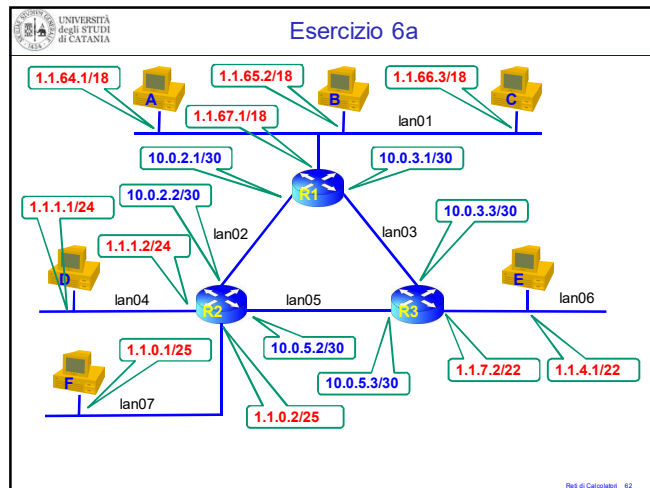
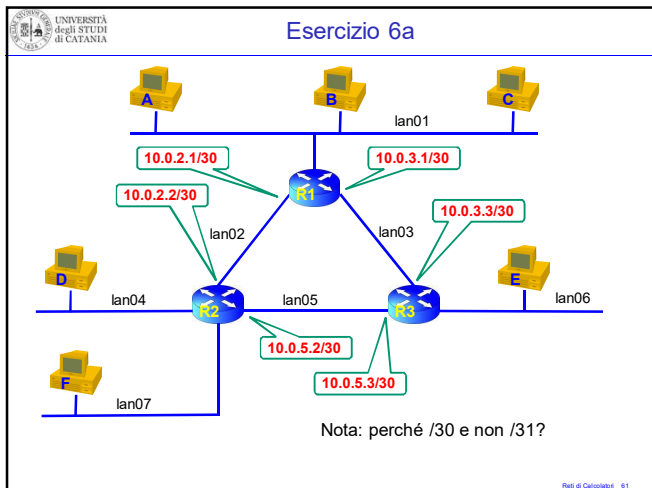
Esercizio 6a

Reti di Calcolatori 59

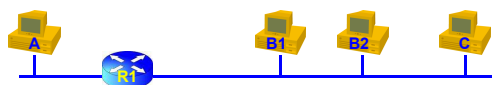
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Esercizio 6a

Reti di Calcolatori 60



Esercizio 10



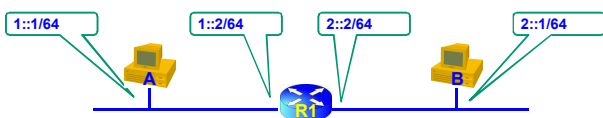
Configurare la rete in modo che, quando B1 è spenta, il traffico diretto a B1 vada in automatico a B2.

Esercizio 11



Configurare la rete utilizzando solo indirizzi IPv6

Esercizio 11



```
ifconfig eth0 inet6 add 1::1/64
ifconfig eth0 up

route -n -A inet6

ping6 1::2
```

Esercizio 11

```
[root@localhost ~]# route -n -A inet6
Kernel IPv6 routing table
Destination      Flags Metric Ref    Use Iface      Next Hop
 0:0:0:0:0:0:0:0  0         0      0 eth0        ::
fe80:::64        0         0      0 eth0        ::
::1/128          0         9      1 lo         ::
1::1/128         0         8      1 lo         ::
fe80::a00:27ff:fe32:b27b/128  0         3      1 lo         ::
ff00:::8         0         0      0 eth0        ::
[root@localhost ~]#
```