RIP – ruting z użyciem protokołu dynamicznego *Routing Information Protocol* (RIP)

- W ramach zajęć zostanie przeprowadzona analiza sieci, składającej się z pięciu ruterów wirtualnych.
- Adresy IP poszczególnych interfejsów tych urządzeń zostały już skonfigurowane.
- W ramach zajęć należy:
  - Zapoznać się z oprogramowaniem **`quagga`**, który jest dostępny w systemie operacyjnym Linux i zapewnia implementację protokołów routingu opartych na TCP/IP: http://www.nongnu.org/quagga/docs/quagga.html
  - Skonfigurować protokół RIP z użyciem plecenia **`telnet`**
  - Dokonać analizy komunikatów protokołu RIP z użyciem polecenia **`tcpdump`**
  - Dokonać propagacji trasy domyślnej w ramach protokołu RIP
  - Zaobserwować dynamikę działania protokołu RIP

RIP – ruting z użyciem protokołu dynamicznego *Routing Information Protocol* (RIP)

- **Głównym celem zajęć jest**
  - konfiguracja dynamicznego protokołu rutingu RIP opartego na algorytmie wektora odległości (ang. *distance vector*)
  - zrozumienie zasad i mechanizmów działania protokołu RIP
  - lepsze zapoznanie się ze środowiskiem **`netkit`**

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netkit lab

rip

Version	2.4
Author(s)	G. Di Battista, M. Patrignani, M. Pizzonia, F. Ricci, M. Rimondini
E-mail	contact@netkit.org
Web	http://www.netkit.org/
Description	experiences with the ripv2 distance vector routing protocol

Modified for the purpose of the IP Networks lab

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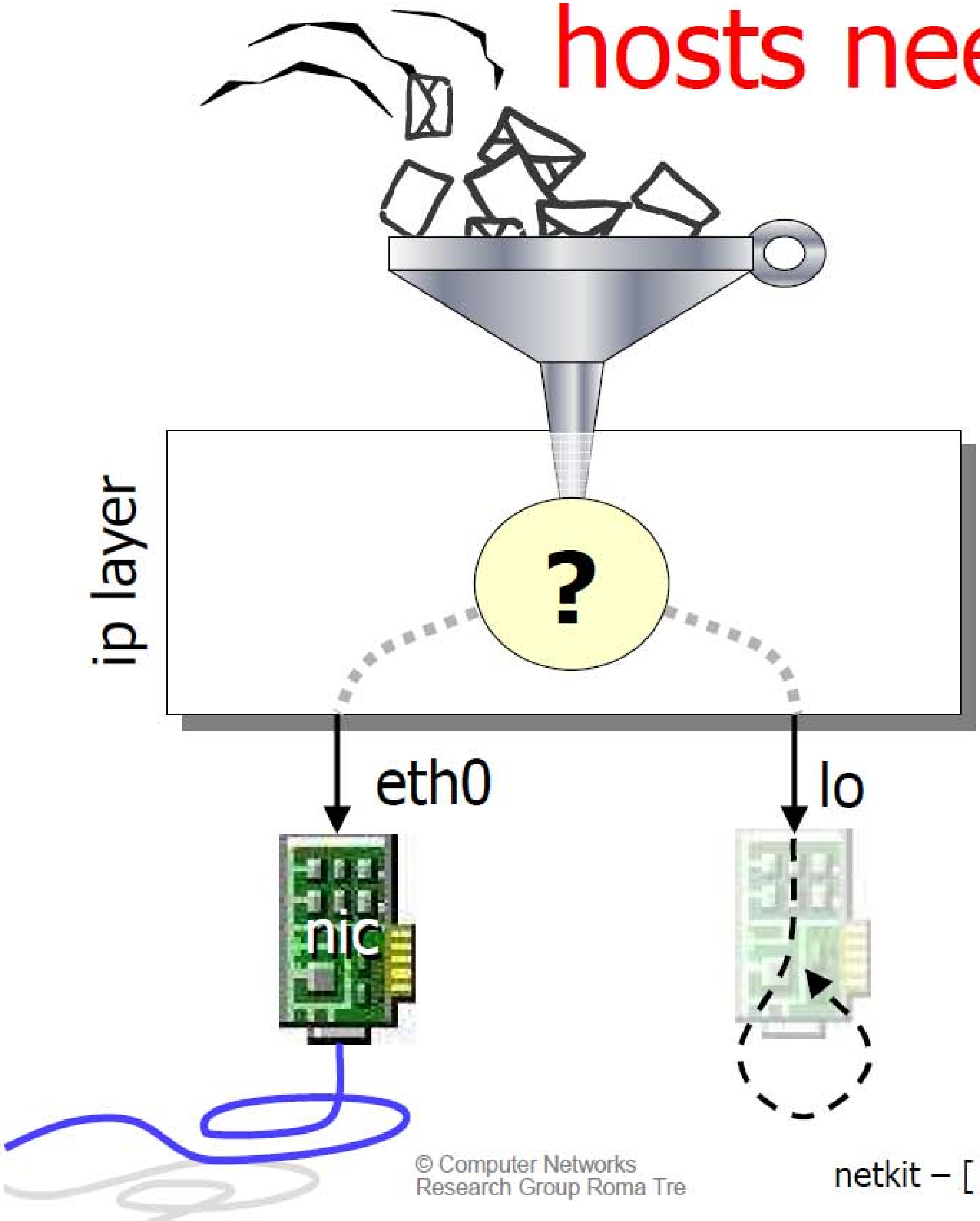
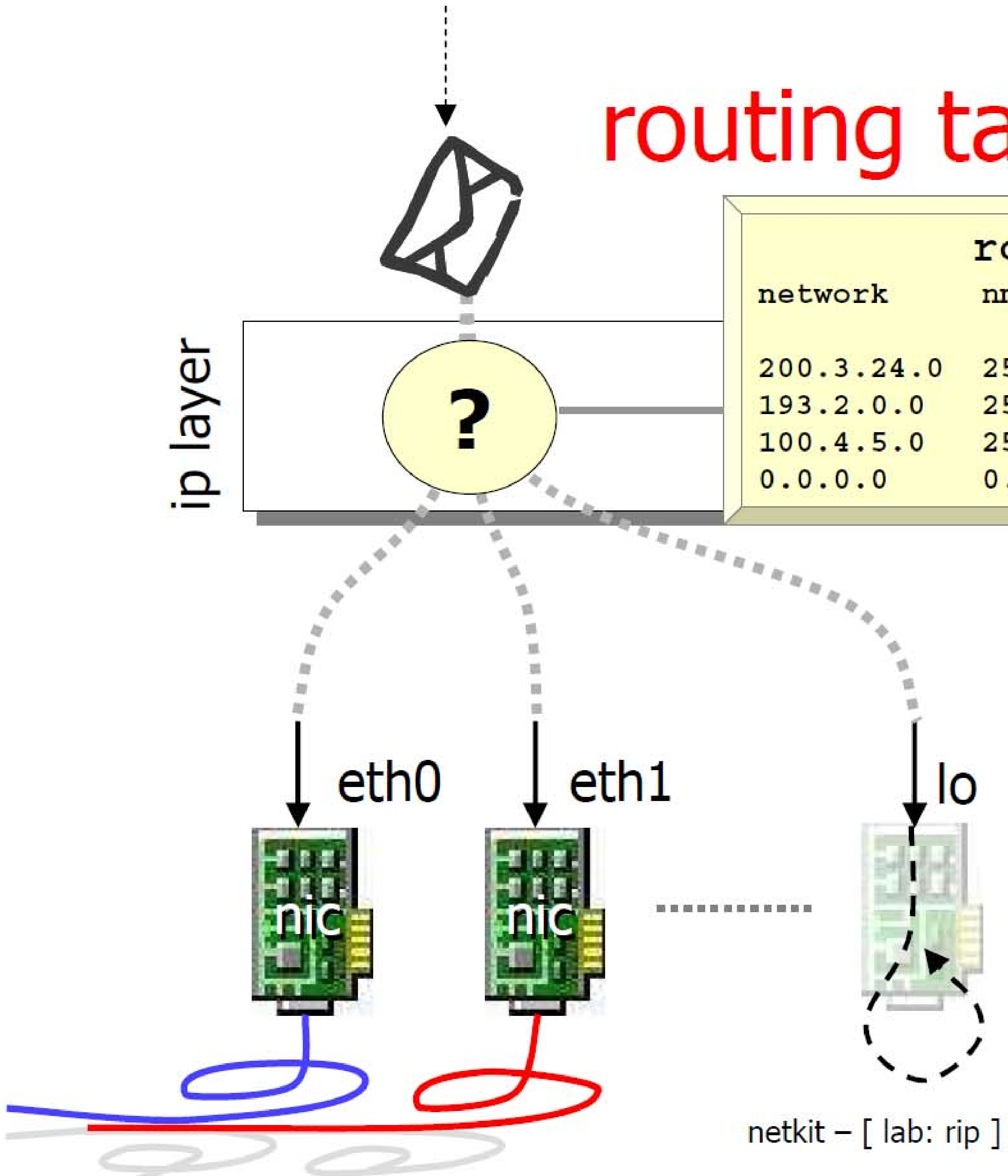
hosts need routing



- each host with a network stack performs some elementary routing
- at the very least, the network stack may be used to access local services (e.g., XWindows)
- the host must decide when a packet needs to be sent to the network interface card (nic) and when it needs to be bounced to the loopback interface (lo)

routing table

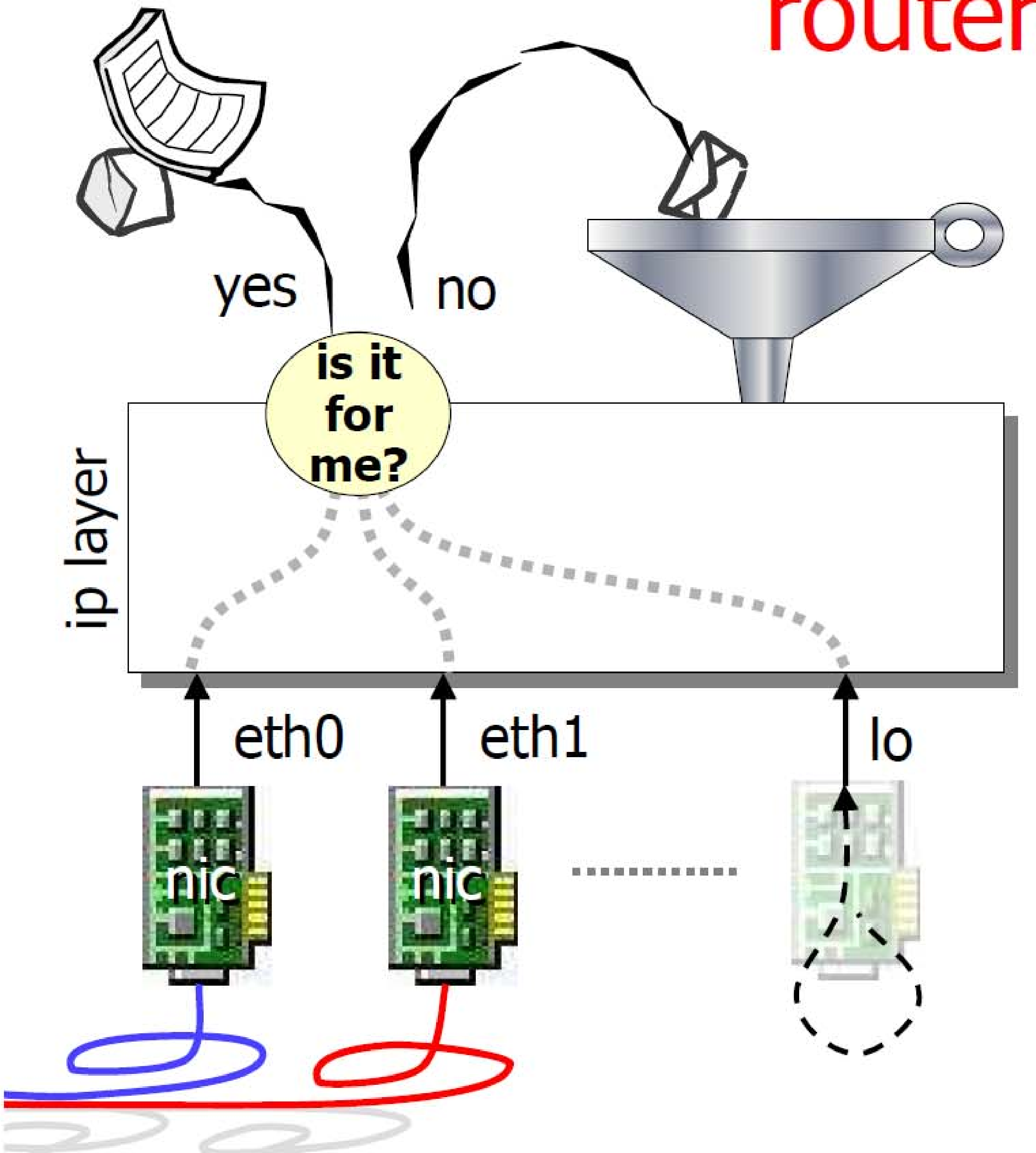


routing table

network	nmask	nexthop	int
200.3.24.0	255.255.255.0	12.0.0.4	eth1
193.2.0.0	255.255.248.0	11.0.0.2	eth0
100.4.5.0	255.240.0.0	11.0.0.3	eth0
0.0.0.0	0.0.0.0	11.0.0.2	eth0

- the ip layer uses a routing table to decide which is the interface the packet needs to be forwarded to

routers

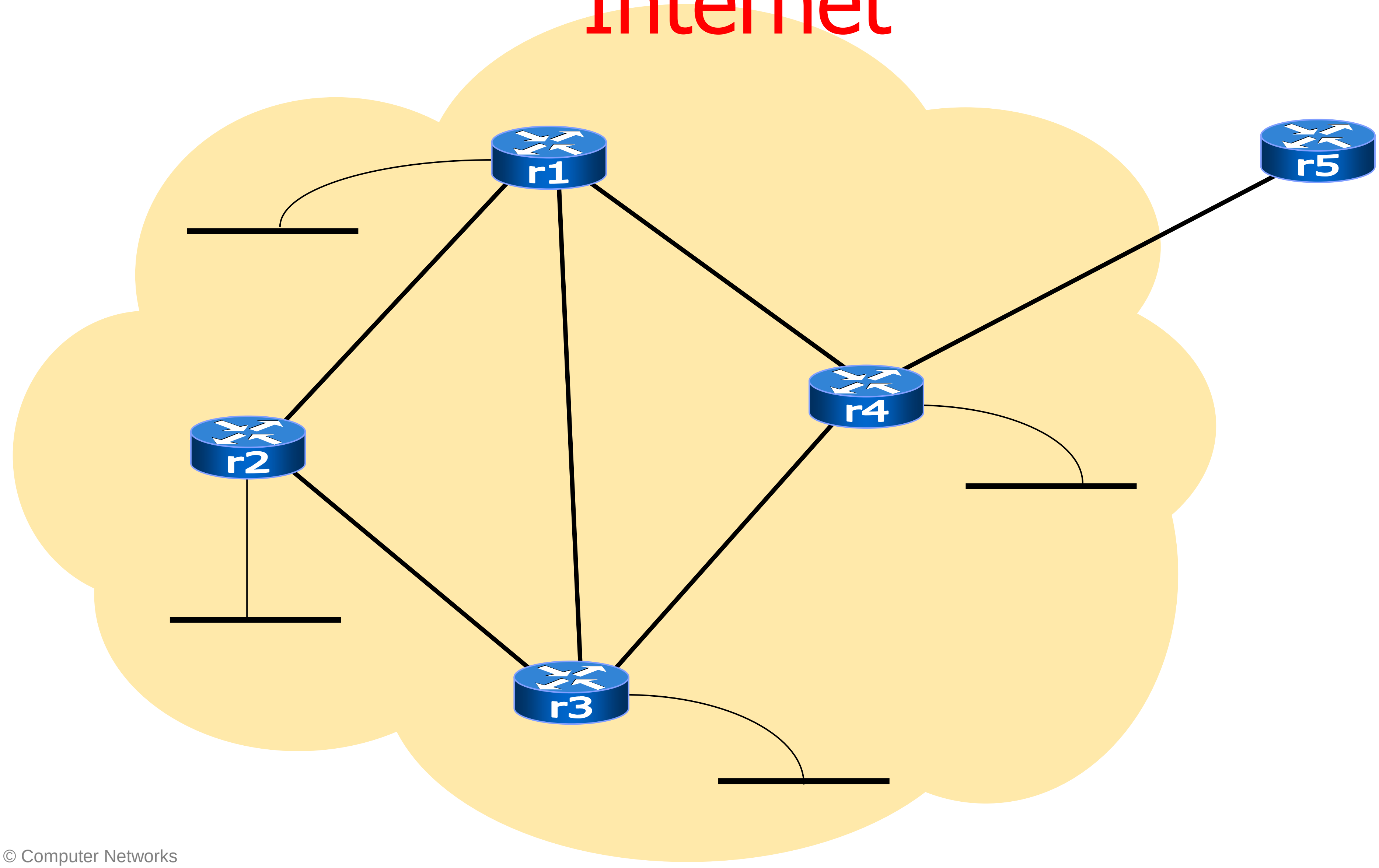


- a router (also called gateway or intermediate-system)
  - has more than one network interface card
  - feeds incoming ip packets (that are not for the router itself) back in the routing process
    - this operation is called relaying or forwarding

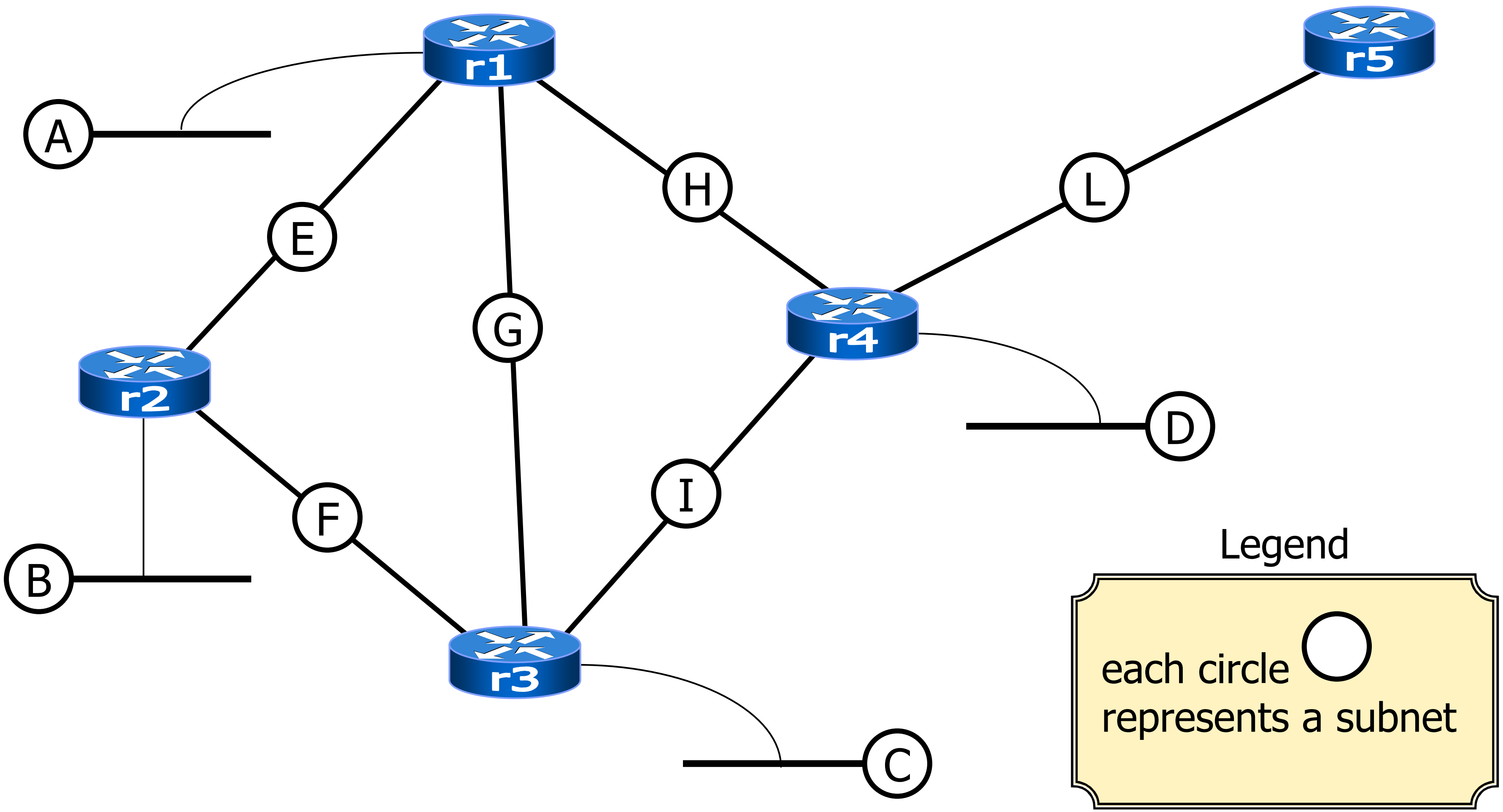
routing protocols

- routing protocols are used to automatically update the routing tables
- they fall into two main cathegories:
  - link-state routing protocols
    - approach: send the minimum information to everyone
    - each router reconstructs the whole network graph and computes a shortest path tree to all destinations
    - examples: is-is, ospf
  - distance-vector routing protocols
    - approach: send all your information to a few
    - update your routing information based on what you hear
    - examples: rip, bgp
- in this lab we will see an example of **RIPv2** protocol on zebra boxes

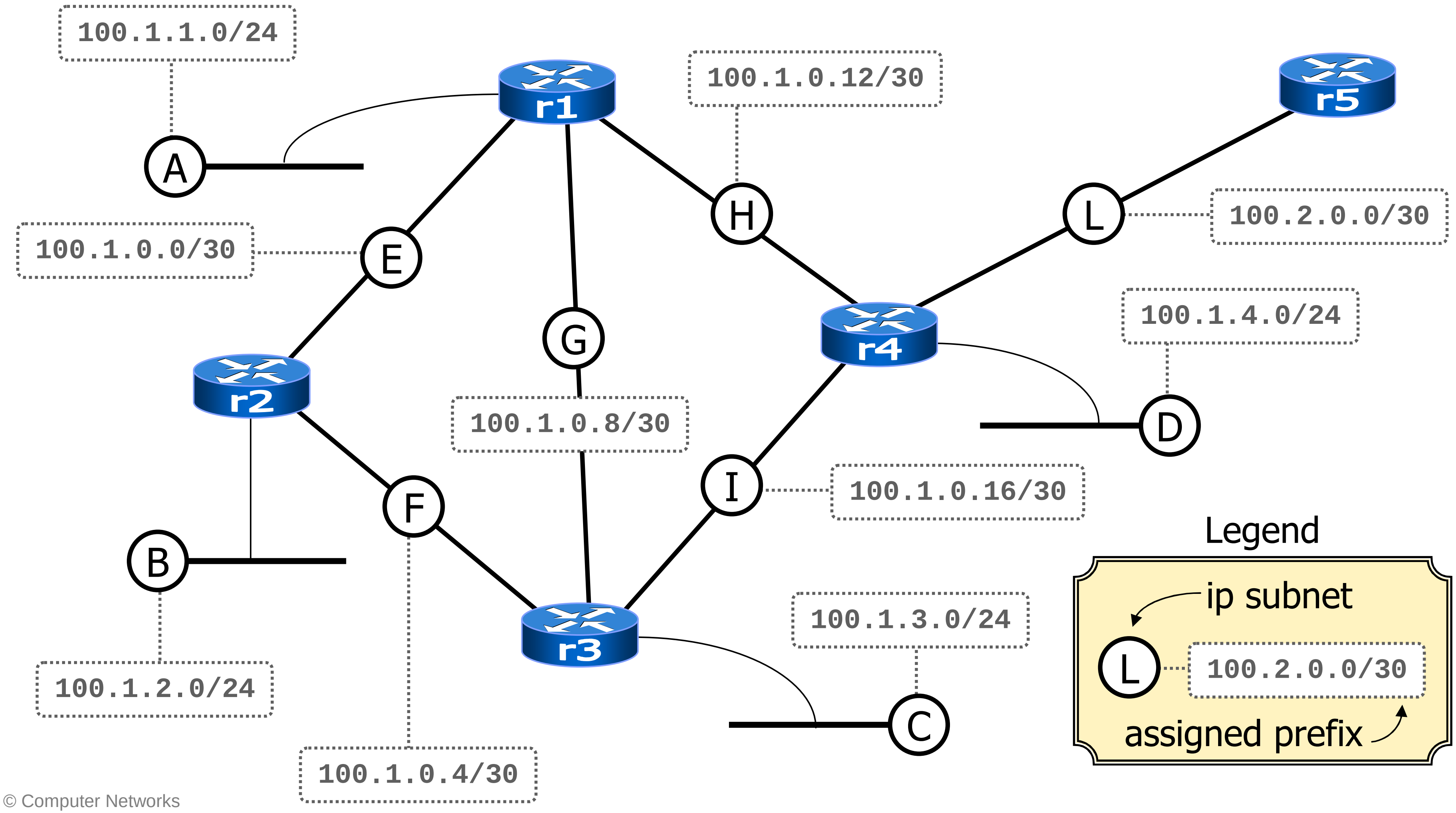
a small network connected to the Internet



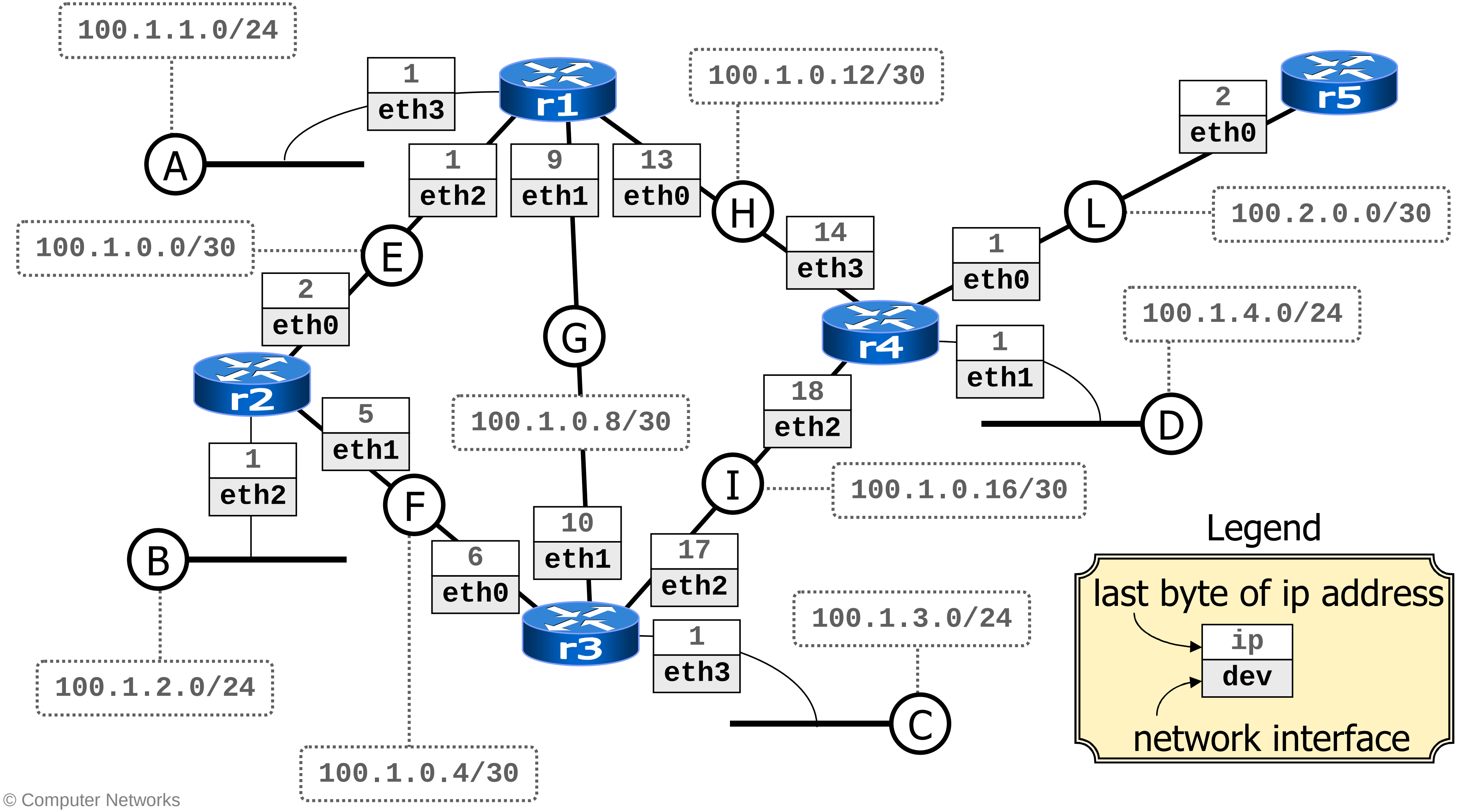
the involved ip subnets



assigning ip numbers to subnets



assigning ip numbers to interfaces



launching the lab script

host machine

```
user@localhost:~$ cd netkit-lab_rip
user@localhost:~/netkit-lab_rip$ lstart
```

- the lab configuration is such that
  - five virtual hosts are created and connected to the right collision domains (virtual hubs)
  - for each virtual host
    - network interfaces are automatically configured
  - the zebra routing daemon is **not** automatically started

Lab Scenario Personalization

- Please modify the default scenario in the following way
  - Change the IP address of the `eth0` interface of `r5` to `100.2.0.<LAB-ID>`, where LAB-ID is your personal ID assigned by the lab instructor
- **Note well**: from now-on
  - Command-line commands should reflect the change in addressing, therefore there can be differences in the outputs shown in the manual

checking connectivity

- towards a directly connected destination

r4

```
r4:~# ping 100.1.0.13
PING 100.1.0.13 (100.1.0.13) 56(84) bytes of data.
64 bytes from 100.1.0.13: icmp_seq=1 ttl=64 time=1.23 ms
64 bytes from 100.1.0.13: icmp_seq=2 ttl=64 time=0.592 ms
64 bytes from 100.1.0.13: icmp_seq=3 ttl=64 time=0.393 ms

--- 100.1.0.13 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2032ms
rtt min/avg/max/mdev = 0.393/0.741/1.238/0.360 ms
r4:~#
```

checking connectivity

- towards a remote destination

r4

```
r4:~# ping 100.1.2.1
connect: Network is unreachable
r4:~# █
```

- what’s going on?

examining the kernel routing table

r4

```
r4:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.1.0.16      *               255.255.255.252 U     0      0        0 eth2
100.2.0.0       *               255.255.255.252 U     0      0        0 eth0
100.1.0.12      *               255.255.255.252 U     0      0        0 eth3
100.1.4.0       *               255.255.255.0   U     0      0        0 eth1
r4:~#
```

- since no routing daemon is currently running, only directly connected destinations are known to the router

inspecting zebra configuration files

```
virtual machine

r1:~# cd /etc/zebra/
r1: /etc/zebra# ls
bgpd.conf            ospf6d.conf          ripd.conf            vtysh.conf
bgpd.conf.sample     ospf6d.conf.sample   ripd.conf.sample     vtysh.conf.sample
bgpd.conf.sample2    ospfd.conf           ripngd.conf          zebra.conf
daemons              ospfd.conf.sample    ripngd.conf.sample   zebra.conf.sample
```

- when zebra is started, each daemon checks these files to read the starting configuration

sample zebra configuration file (zebra.conf)

virtual machine

```
pc1:/etc/zebra# less zebra.conf
! -*- zebra -*-
!
! zebra sample configuration file
!
! $Id: zebra.conf.sample,
Exp $
!
hostname Router
password zebra
enable password zebra
!
! interface lo
zebra.conf
```

the prompt of the zebra interface

the password to connect to the daemon

administrative password

`daemons` file

- make changes in the daemons files on **`r1`**, **`r2`**, **`r3`**, **`r4`**
  path: **`/etc/zebra/daemons`**
- change "**`no`**" into "**`yes`**" for **`zebra`** and **`ripd`** to start the main and rip daemons in future steps

starting the routing daemons on **routers r1, r2, r3, r4 (without r5)**

- issue the command

```
r:~# /etc/init.d/zebra start
Starting Zebra daemons (prio:10): zebra ripd.
r:~#
```

Configuring RIP on **each router (without r5)**

- telnet to **ripd** and configure rip
- associate **apropriate** networks with RIP process
- write changes in the **ripd.conf** file

```
r:~# telnet localhost ripd
ripd> enable
ripd# configure terminal
ripd(config)# router rip
ripd(config-router)# network X.X.X.X/Y
ripd(config-router)# write file
```

Be careful when defining interfaces on which RIP runs. Should RIP be spoken on each interface? Control the advertisement of routing information in your network.

checking connectivity (again)

- towards a remote destination

```
r4
r4:~# ping 100.1.2.1
PING 100.1.2.1 (100.1.2.1) 56(84) bytes of data.
64 bytes from 100.1.2.1: icmp_seq=1 ttl=63 time=0.743 ms
64 bytes from 100.1.2.1: icmp_seq=2 ttl=63 time=0.875 ms
64 bytes from 100.1.2.1: icmp_seq=3 ttl=63 time=0.685 ms

--- 100.1.2.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2005ms
rtt min/avg/max/mdev = 0.685/0.767/0.875/0.085 ms
r4:~#
```

- after a while, all remote destinations are reachable

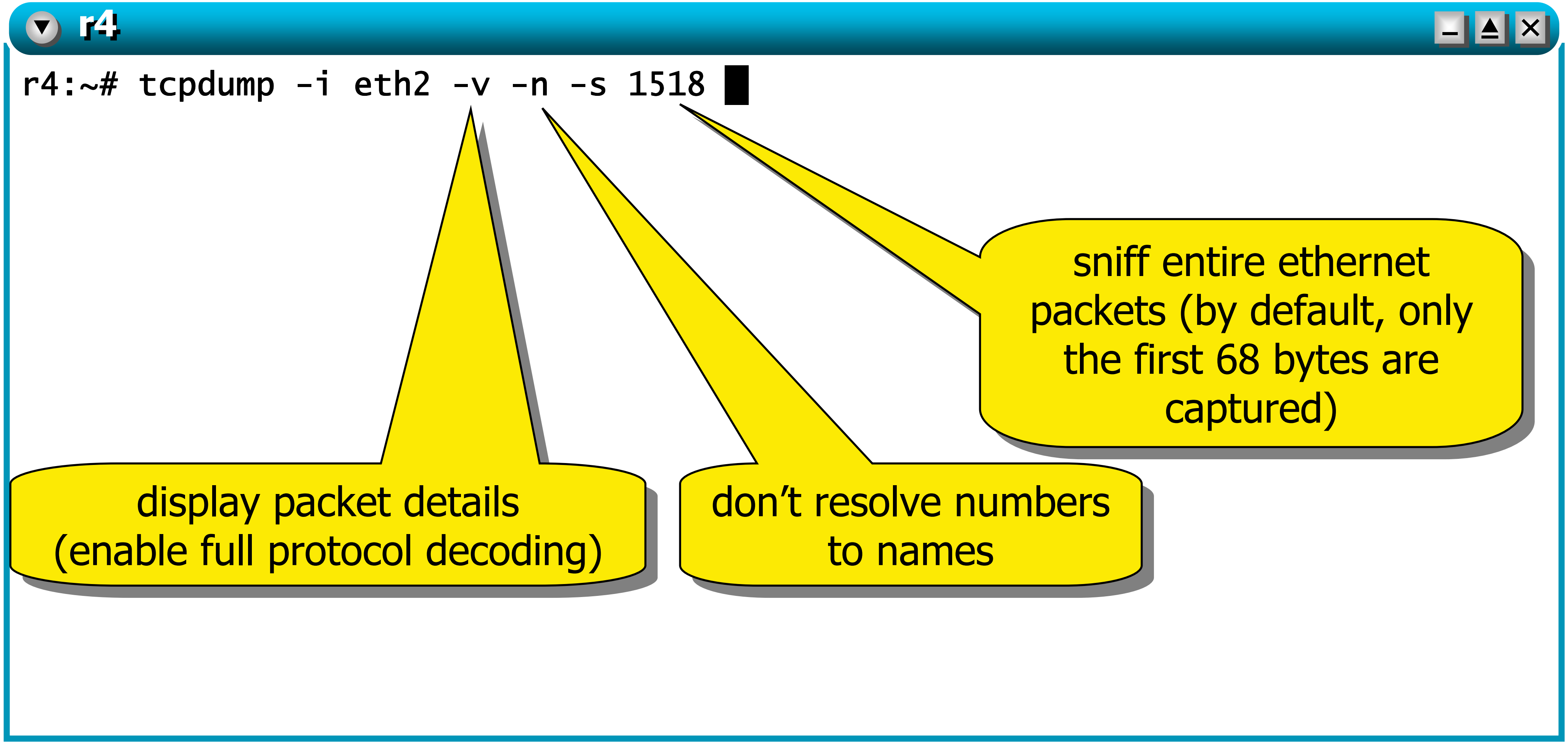
checking the routing table

- the routing table is now updated

```
r4
r4:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.1.0.16      *               255.255.255.252 U     0      0        0 eth2
100.1.0.0       100.1.0.13      255.255.255.252 UG    2      0        0 eth3
100.1.0.4       100.1.0.17      255.255.255.252 UG    2      0        0 eth2
100.2.0.0       *               255.255.255.252 U     0      0        0 eth0
100.1.0.8       100.1.0.17      255.255.255.252 UG    2      0        0 eth2
100.1.0.12      *               255.255.255.252 U     0      0        0 eth3
100.1.4.0       *               255.255.255.0   U     0      0        0 eth1
100.1.2.0       100.1.0.17      255.255.255.0   UG    3      0        0 eth2
100.1.3.0       100.1.0.17      255.255.255.0   UG    2      0        0 eth2
100.1.1.0       100.1.0.13      255.255.255.0   UG    2      0        0 eth3
r4:~#
```

a look at ripv2 packets

- let's sniff ripv2 packets



a look at ripv2 packets

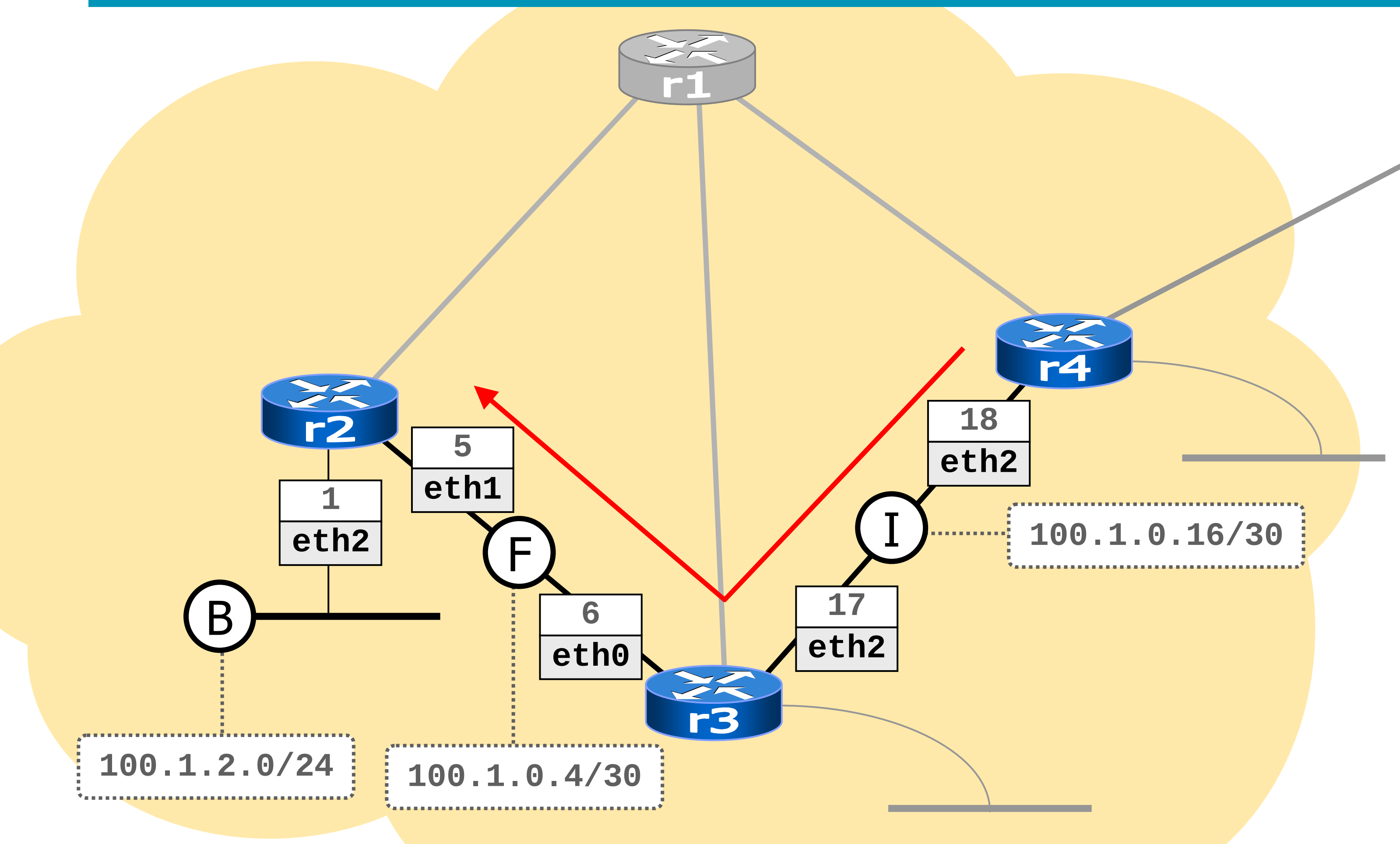
- let's sniff ripv2 packets

```
r4:~# tcpdump -i eth2 -v -n -s 1518
tcpdump: listening on eth2, link-type EN10MB (Ethernet), capture size 1518
bytes
16:47:48.333986 IP (tos 0x0, ttl   1, id 0, offset 0, flags [DF], length: 152)
100.1.0.17.520 > 224.0.0.9.520: [udp sum ok]
        RIPv2, Response, length: 124, routes: 6
          AFI: IPv4:       100.1.0.0/30, tag 0x0000, metric: 2, next-hop: self
          AFI: IPv4:       100.1.0.4/30, tag 0x0000, metric: 1, next-hop: self
          AFI: IPv4:       100.1.0.8/30, tag 0x0000, metric: 1, next-hop: self
          AFI: IPv4:       100.1.1.0/24, tag 0x0000, metric: 2, next-hop: self
          AFI: IPv4:       100.1.2.0/24, tag 0x0000, metric: 2, next-hop: self
          AFI: IPv4:       100.1.3.0/24, tag 0x0000, metric: 1, next-hop: self

1 packets captured
1 packets received by filter
0 packets dropped by kernel
r4:~#
```

a traceroute

r4

```
r4:~# traceroute 100.1.2.1
traceroute to 100.1.2.1 (100.1.2.1), 64 hops max, 40 byte packets
 1  100.1.0.17 (100.1.0.17)  10 ms  3 ms  1 ms
 2  100.1.2.1 (100.1.2.1)  15 ms  1 ms  1 ms
r4:~#
```

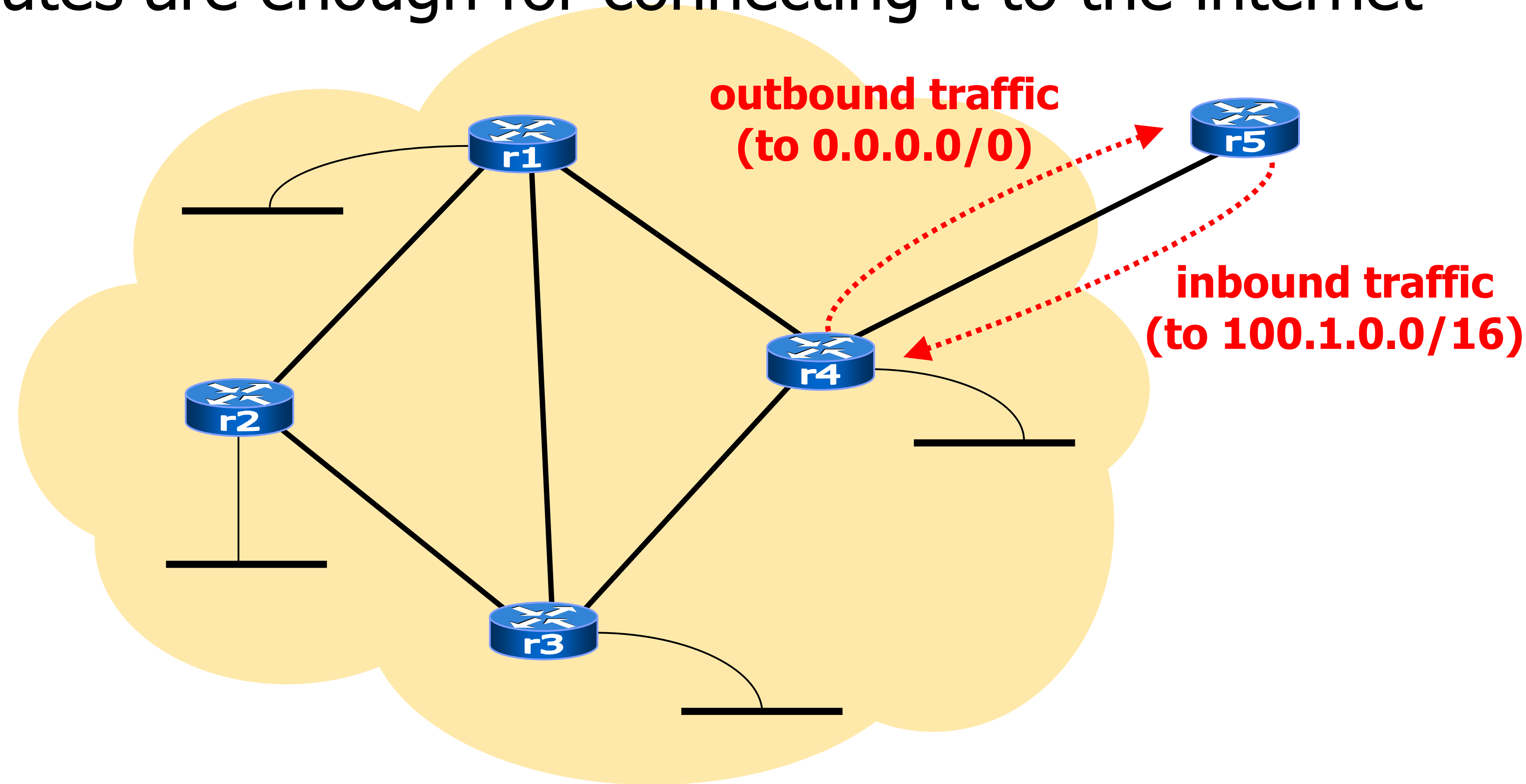


inspecting the rip routing table

```
r4
r4:~# telnet localhost ripd
......
Password: zebra
ripd> show ip rip
Codes: R - RIP, C - connected, O - OSPF, B - BGP
       (n) - normal, (s) - static, (d) - default, (r) - redistribute,
       (i) - interface

     Network            Next Hop         Metric From            Time
R(n) 100.1.0.0/30       100.1.0.13            2 100.1.0.13      02:43
R(n) 100.1.0.4/30       100.1.0.17            2 100.1.0.17      02:46
R(n) 100.1.0.8/30       100.1.0.17            2 100.1.0.17      02:46
C(i) 100.1.0.12/30      0.0.0.0               1 self
C(i) 100.1.0.16/30      0.0.0.0               1 self
R(n) 100.1.1.0/24       100.1.0.13            2 100.1.0.13      02:43
R(n) 100.1.2.0/24       100.1.0.17            3 100.1.0.17      02:46
R(n) 100.1.3.0/24       100.1.0.17            2 100.1.0.17      02:46
C(i) 100.1.4.0/24       0.0.0.0               1 self
C(r) 100.2.0.0/30       0.0.0.0               1 self
ripd> █
```

static routing

- our network is a stub network (i.e., it has just one connection to an external router, **`r5`**); hence, static routes are enough for connecting it to the internet



adding a **static route** to `r5`

r5

```
r5:~# route add -net 100.1.0.0/16 gw 100.2.0.1
r5:~# ping 100.1.2.1
```

Let eth0 of r4 to participate in RIP
Add an appropriate configuration to ripd

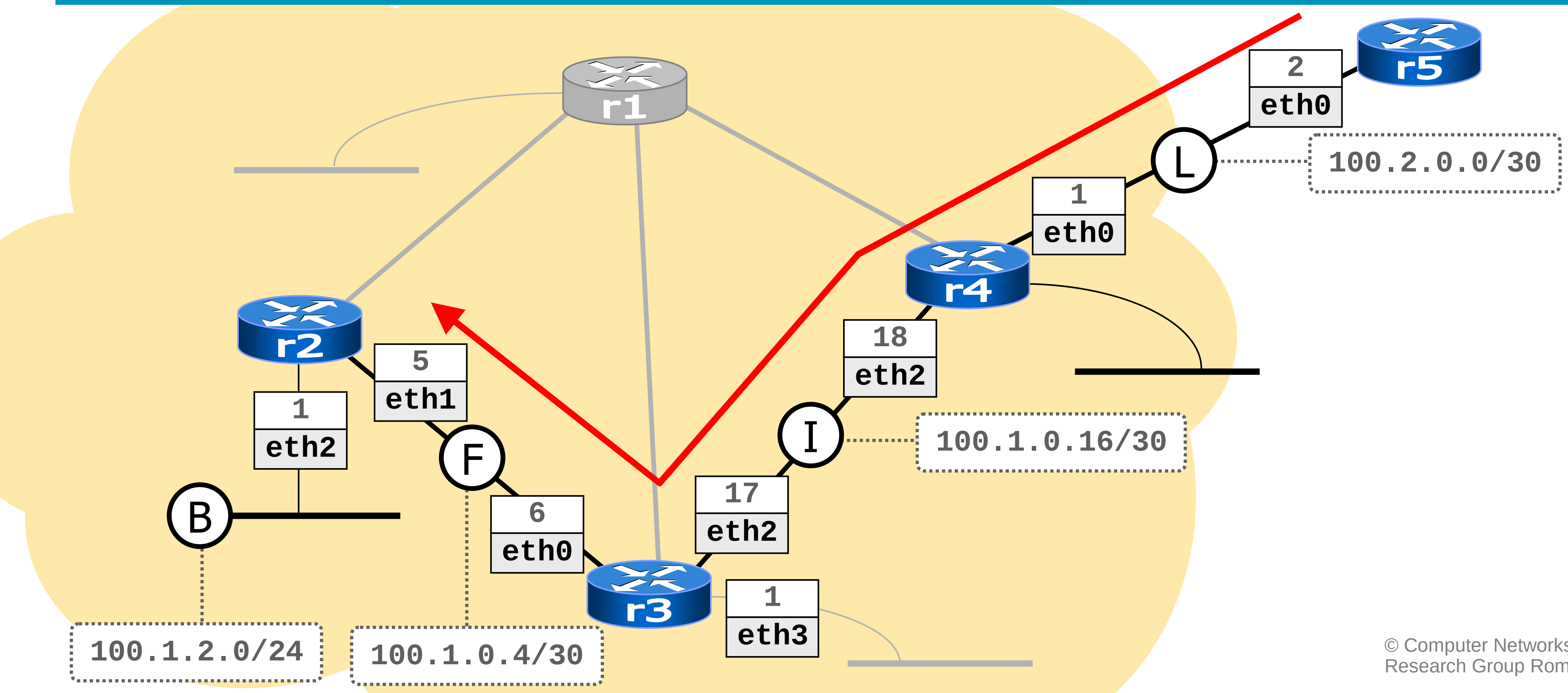
Hints

```
ripd(conig-router)# redistribute connected
ripd(config-router)# write file
```

checking connectivity

r5

```
r5:~# traceroute 100.1.2.1
traceroute to 100.1.2.1 (100.1.2.1), 64 hops max, 40 byte packets
 1  100.2.0.1 (100.2.0.1)  75 ms  1 ms  2 ms
 2  100.1.0.17 (100.1.0.17)  7 ms  1 ms  1 ms
 3  100.1.2.1 (100.1.2.1)  24 ms  3 ms  1 ms
r5:~# 
```



Reporting

- Please deliver the following items to the UPEL system using your account
  1. A photocopy or a screenshot showing the output of the following command
     - **`traceroute 100.1.2.1`** executed on r5

configuring r4

- step 1: configuring the default route

```
r4:~# route add default gw 100.2.0.2
r4:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.1.0.16      *               255.255.255.252 U     0      0        0 eth2
100.1.0.0       100.1.0.13      255.255.255.252 UG    2      0        0 eth3
100.1.0.4       100.1.0.17      255.255.255.252 UG    2      0        0 eth2
100.2.0.0       *               255.255.255.252 U     0      0        0 eth0
100.1.0.8       100.1.0.17      255.255.255.252 UG    2      0        0 eth2
100.1.0.12      *               255.255.255.252 U     0      0        0 eth3
100.1.4.0       *               255.255.255.0   U     0      0        0 eth1
100.1.2.0       100.1.0.17      255.255.255.0   UG    3      0        0 eth2
100.1.3.0       100.1.0.17      255.255.255.0   UG    2      0        0 eth2
100.1.1.0       100.1.0.13      255.255.255.0   UG    2      0        0 eth3
default         100.2.0.2       0.0.0.0         UG    0      0        0 eth0
r4:~#
```

configuring r4

- step 2: propagating the default route into rip

r4

```
r4:~# telnet localhost ripd
Trying 127.0.0.1...
Connected to r4.
Escape character is '^]'.

Hello, this is zebra (version 0.94).
Copyright 1996-2002 Kunihiro Ishiguro.


User Access Verification

Password: zebra
ripd> enable
Password: zebra
ripd# configure terminal
ripd(config)# router rip
ripd(config-router)# route 0.0.0.0/0
ripd(config-router)# quit
ripd(config)# quit
ripd# disable
ripd> exit
```

- `ripd> enable`: work as a privileged user
- `ripd# configure terminal`: begin configuration
- `ripd(config)# router rip`: configure the rip protocol
- `ripd(config-router)# route 0.0.0.0/0`: statically configure the default route
- `ripd(config-router)# quit`: end of rip configuration
- `ripd(config)# quit`: end configuration
- `ripd# disable`: abandon privileges

the default route

- after a while, the default route has been injected (via rip) into the network

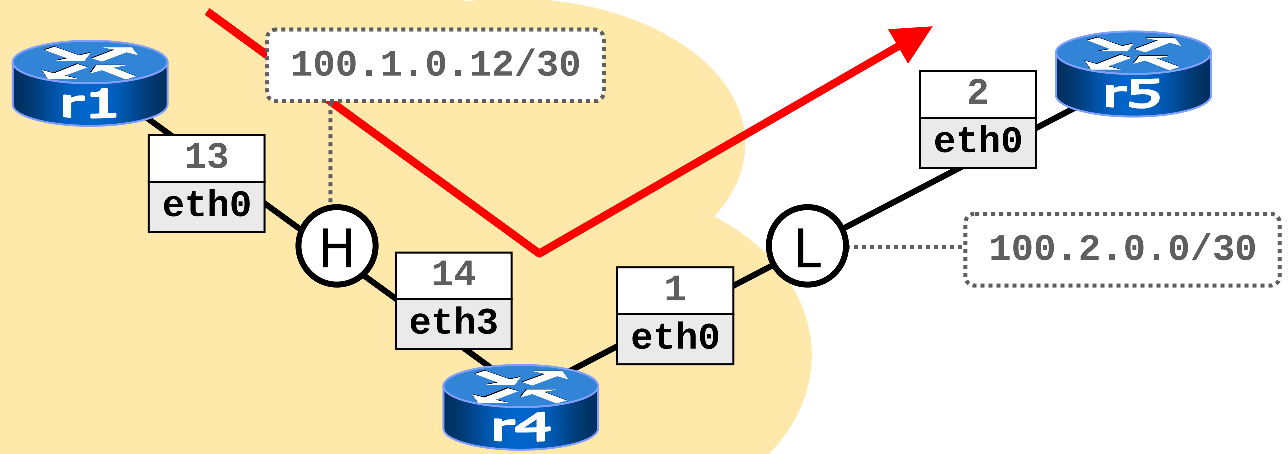
```
r1:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.1.0.16      100.1.0.10      255.255.255.252 UG    2      0        0 eth1
100.1.0.0       *               255.255.255.252 U     0      0        0 eth2
100.2.0.0       100.1.0.14      255.255.255.252 UG    2      0        0 eth0
100.1.0.4       100.1.0.2       255.255.255.252 UG    2      0        0 eth2
100.1.0.8       *               255.255.255.252 U     0      0        0 eth1
100.1.0.12      *               255.255.255.252 U     0      0        0 eth0
100.1.4.0       100.1.0.14      255.255.255.0   UG    2      0        0 eth0
100.1.2.0       100.1.0.2       255.255.255.0   UG    2      0        0 eth2
100.1.3.0       100.1.0.10      255.255.255.0   UG    2      0        0 eth1
100.1.1.0       *               255.255.255.0   U     0      0        0 eth3
default         100.1.0.14      0.0.0.0         UG    2      0        0 eth0
r1:~#
```

checking connectivity

r1

any (even non-existing) destination

```
r1:~# ping 193.204.161.1
PING 193.204.161.1 (193.204.161.1) 56(84) bytes of data.
From 100.2.0.2 icmp_seq=1 Destination Net Unreachable
From 100.2.0.2 icmp_seq=2 Destination Net Unreachable

--- 193.204.161.1 ping statistics ---
2 packets transmitted, 0 received, +2 errors, 100% packet loss,
time 999ms

r1:~#
```



checking connectivity

- **r5** is actually receiving echo request packets

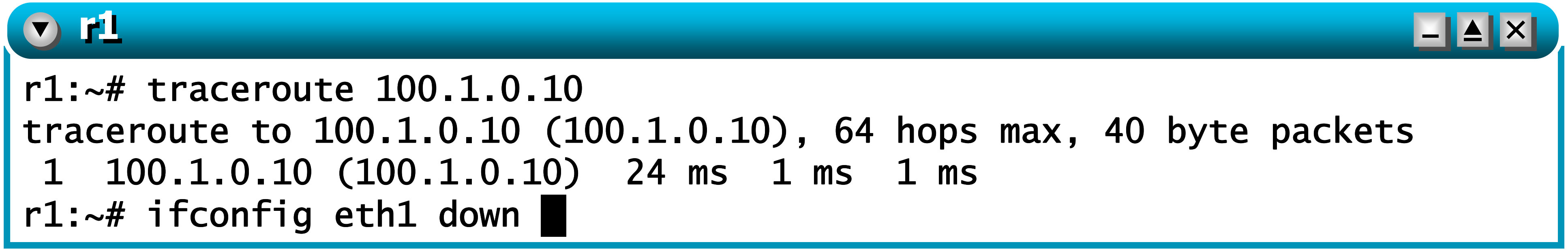
r5

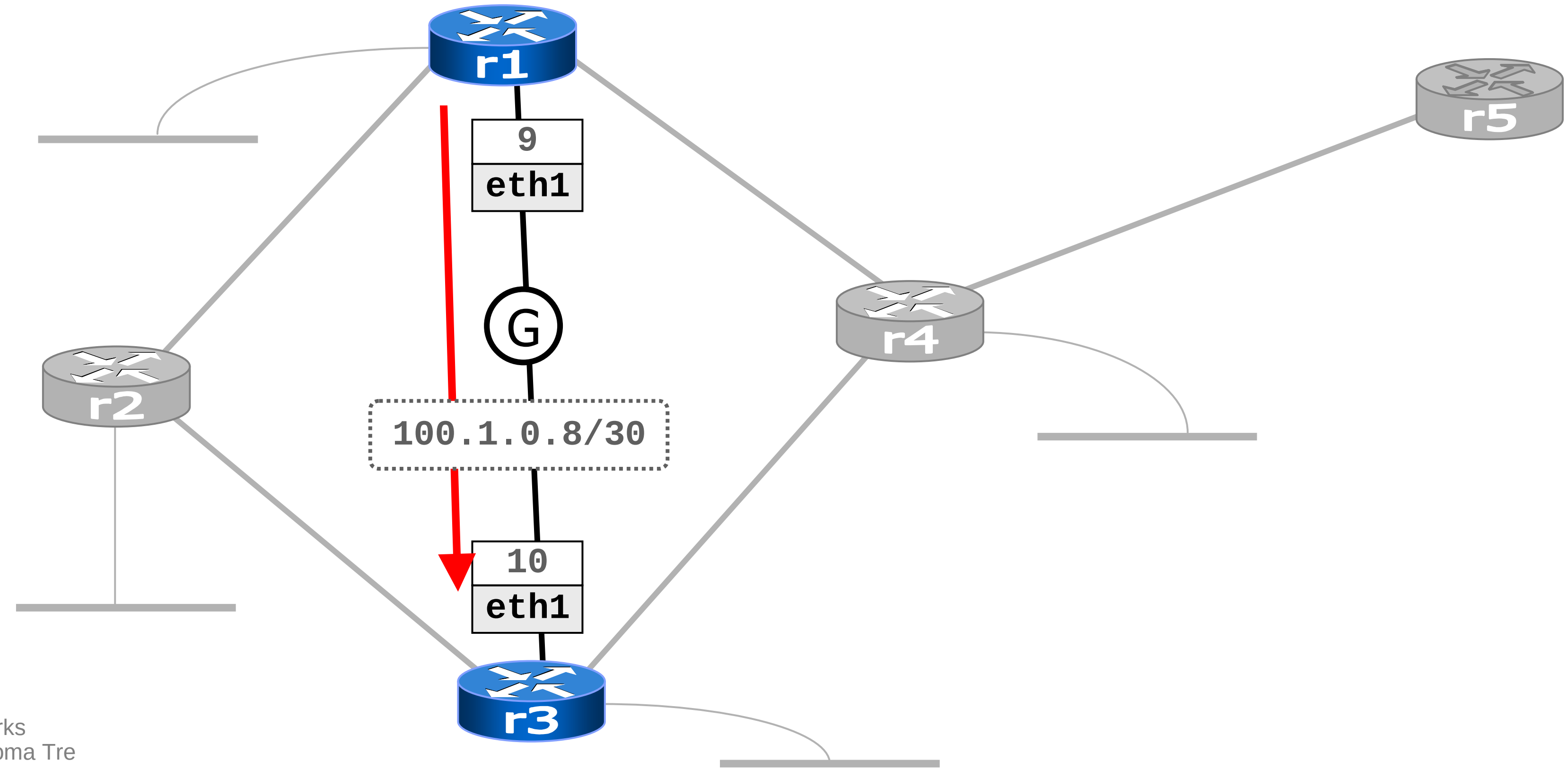
```
r5:~# tcpdump -i eth0 -n -s 1518
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 1518 bytes
11:38:43.822503 arp who-has 100.2.0.2 tell 100.2.0.1
11:38:43.824221 arp reply 100.2.0.2 is-at fe:fd:64:02:00:02
11:38:43.825890 IP 100.1.0.13 > 193.204.161.1: icmp 64: echo request seq 1
11:38:43.827139 IP 100.2.0.2 > 100.1.0.13: icmp 92: net 193.204.161.1
unreachable
11:38:44.841566 IP 100.1.0.13 > 193.204.161.1: icmp 64: echo request seq 2
11:38:44.841651 IP 100.2.0.2 > 100.1.0.13: icmp 92: net 193.204.161.1
unreachable

6 packets captured
6 packets received by filter
0 packets dropped by kernel
r5:~#
```

Reporting

- Please deliver the following items to the UPEL system using your account
  1. A photocopy or a screenshot showing the output of the **`tcpdump -i eth0 -n -s 1518`** command executed on r5 (from the previous slide)

shutting down an interface

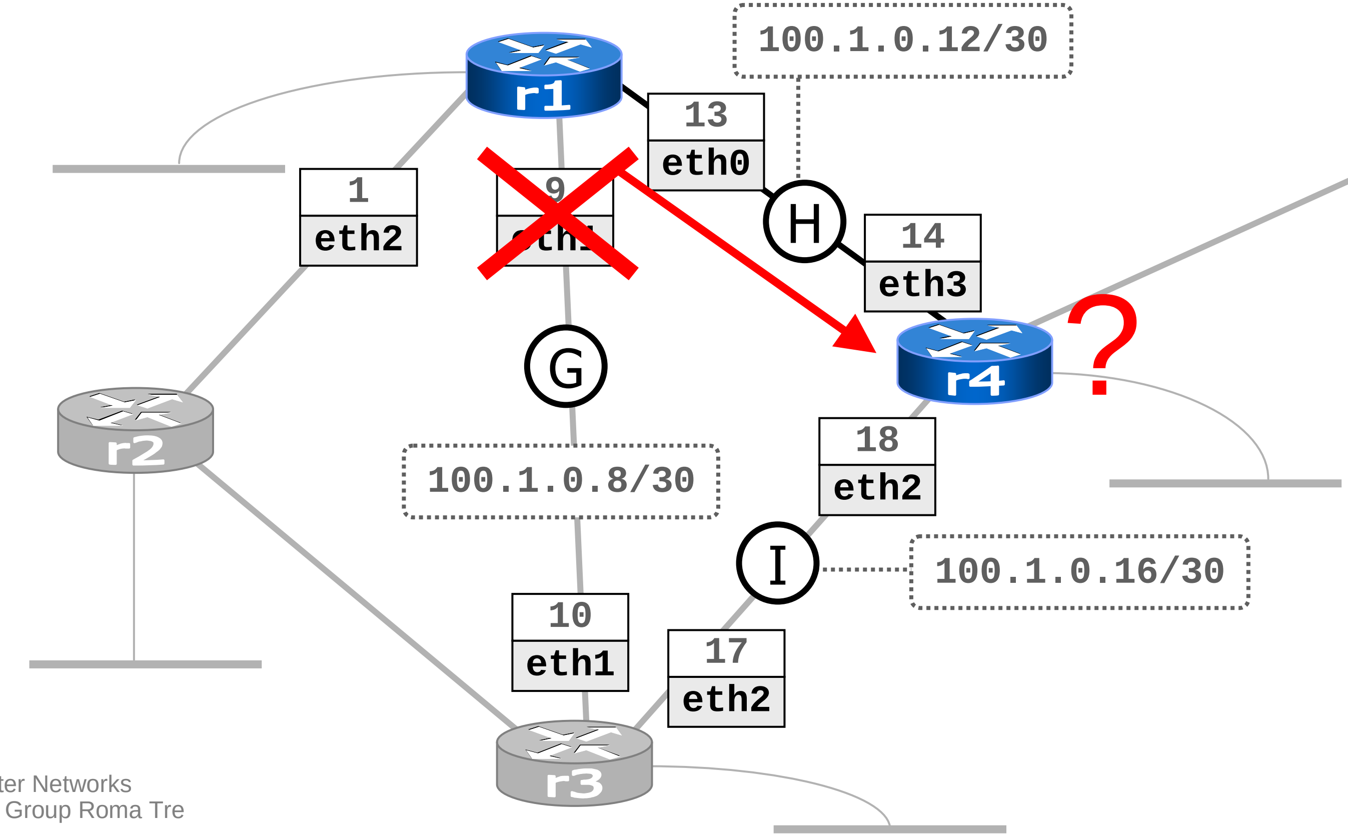




shutting down an interface

r1

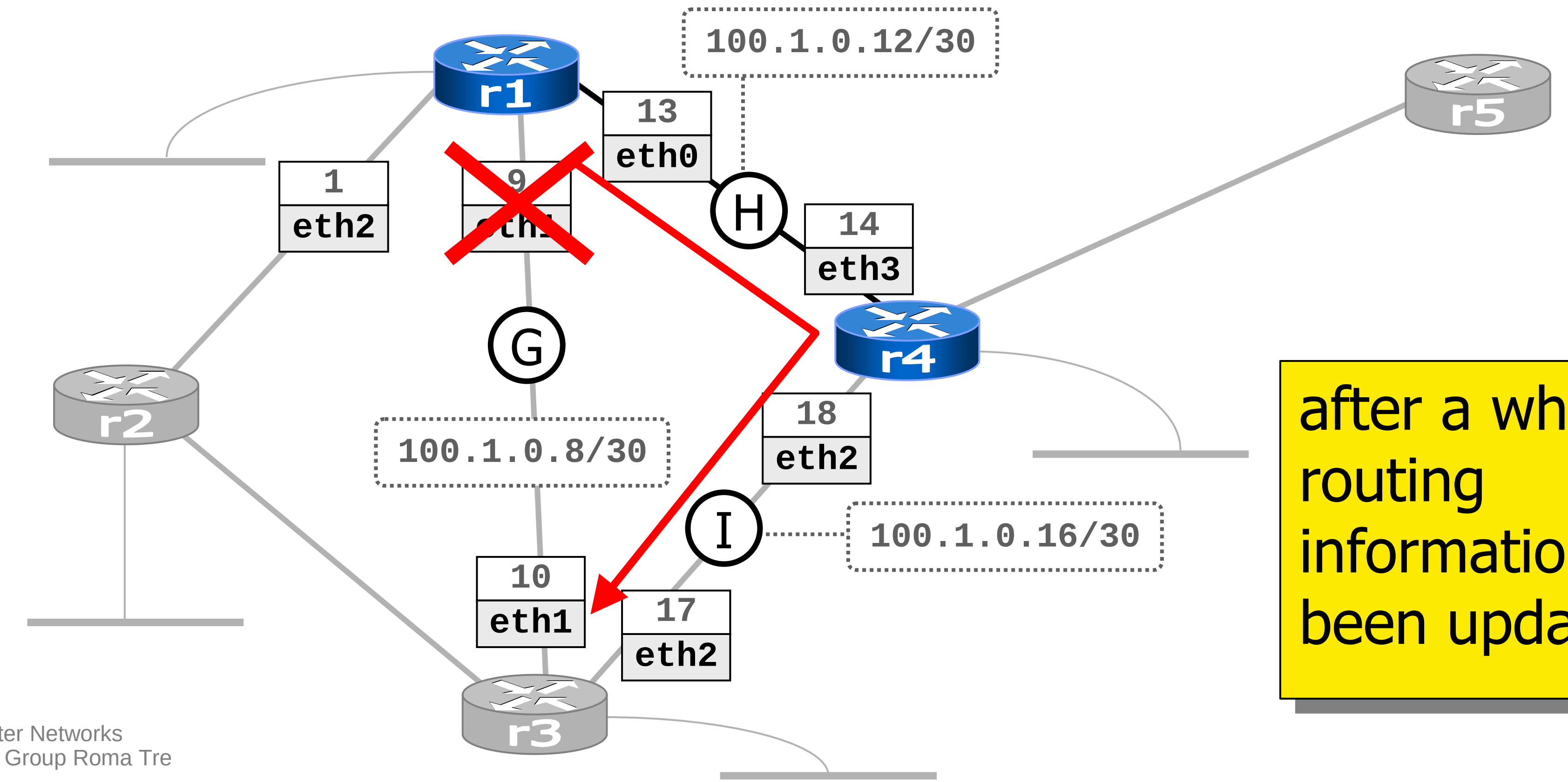
```
r1:~# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
 1  100.1.0.14 (100.1.0.14)  1 ms  1 ms  1 ms
 2  * * *
 3  * * *
```



r1 attempts forwarding the packet using the default route

shutting down an interface

```
r1:~# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
 1  100.1.0.14 (100.1.0.14)  1 ms  1 ms  1 ms
 2  100.1.0.10 (100.1.0.10)  5 ms  2 ms  1 ms
r1:~#
```



after a while, routing information has been updated

shutting down an interface

- **r1**'s routing table has been updated

```
r1:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.1.0.16      100.1.0.14      255.255.255.252 UG    2      0        0 eth0
100.1.0.0       *               255.255.255.252 U     0      0        0 eth2
100.2.0.0       100.1.0.14      255.255.255.252 UG    2      0        0 eth0
100.1.0.4       100.1.0.2       255.255.255.252 UG    2      0        0 eth2
100.1.0.8       100.1.0.14      255.255.255.252 UG    3      0        0 eth0
100.1.0.12      *               255.255.255.252 U     0      0        0 eth0
100.1.4.0       100.1.0.14      255.255.255.0   UG    2      0        0 eth0
100.1.2.0       100.1.0.2       255.255.255.0   UG    2      0        0 eth2
100.1.3.0       100.1.0.14      255.255.255.0   UG    3      0        0 eth0
100.1.1.0       *               255.255.255.0   U     0      0        0 eth3
default         100.1.0.14      0.0.0.0         UG    2      0        0 eth0
r1:~#
```

about `redistribute connected`

- by default (i.e., without further configuration) RIP already propagates information about directly connected subnets...
  ...attached to RIP-speaking interfaces only
- `redistribute connected` forces RIP to propagate information about *all* connected subnets

- the semantic of `redistribute connected` applies to all routing protocols
- the default behavior does not: some protocols (e.g., bgp) are lazier, and do not propagate anything unless explicitly told to do so