



Università degli Studi Roma Tre  
Dipartimento di Informatica e Automazione  
Computer Networks Research Group

# netkit lab

## rip

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

# copyright notice

- All the pages/slides in this presentation, including but not limited to, images, photos, animations, videos, sounds, music, and text (hereby referred to as “material”) are protected by copyright.
- This material, with the exception of some multimedia elements licensed by other organizations, is property of the authors and/or organizations appearing in the first slide.
- This material, or its parts, can be reproduced and used for didactical purposes within universities and schools, provided that this happens for non-profit purposes.
- Information contained in this material cannot be used within network design projects or other products of any kind.
- Any other use is prohibited, unless explicitly authorized by the authors on the basis of an explicit agreement.
- The authors assume no responsibility about this material and provide this material “as is”, with no implicit or explicit warranty about the correctness and completeness of its contents, which may be subject to changes.
- This copyright notice must always be redistributed together with the material, or its portions.

# routing protocols

- routing protocols are used to automatically update the routing tables
- they fall into two main categories:
  - 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

# sample ripd configuration file (ripd.conf)

```
virtual machine
pc1:/etc/zebra# cat ripd.conf
!
hostname ripd
password root
enable password root
!
router rip
redistribute connected
network 100.1.0.0/16
!
log file /var/log/zebra/ripd.log
pc1:/etc/zebra#
```

talk rip on some interface

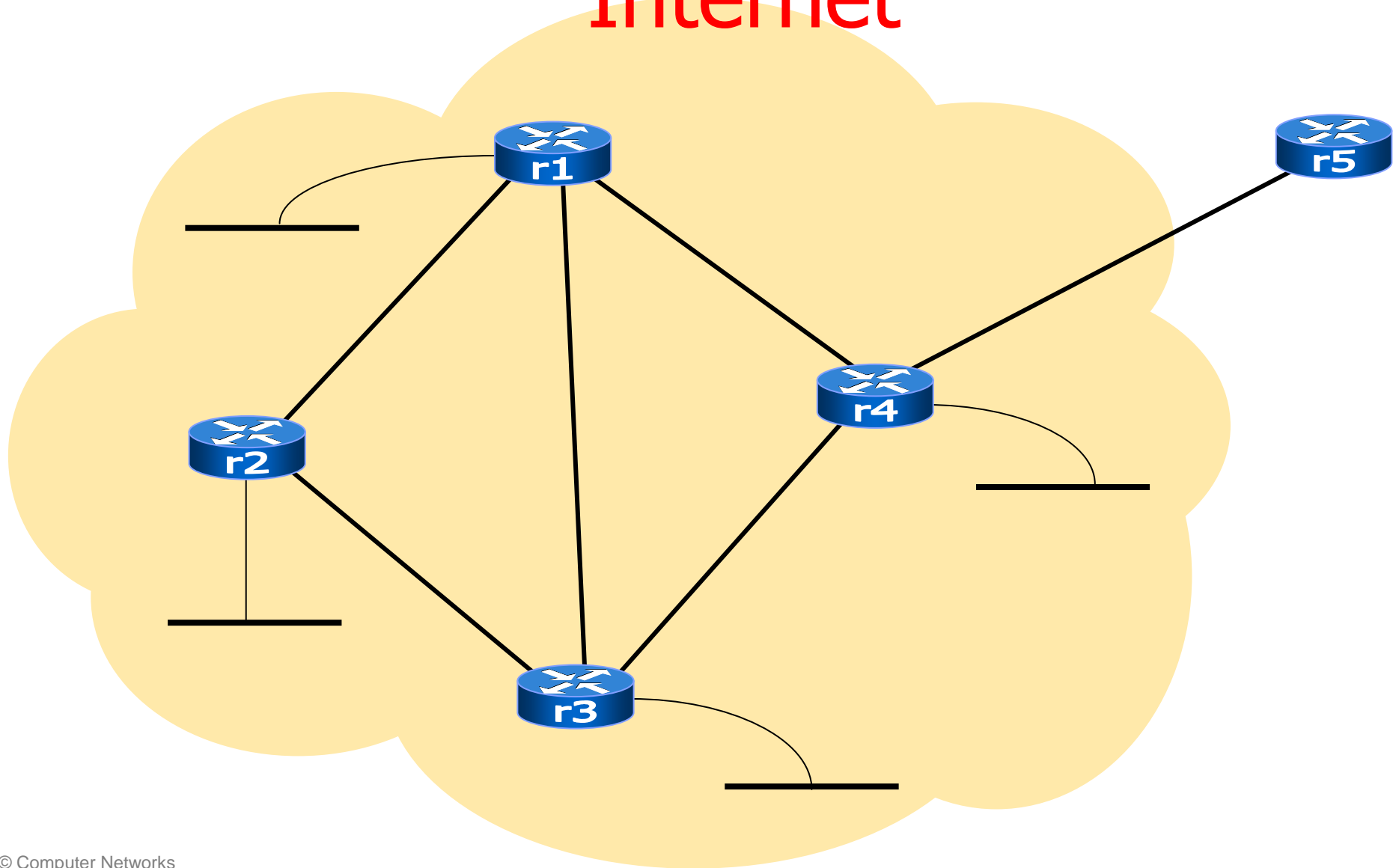
redistribute to rip neighbors information about all directly connected subnets

send rip multicast packets to interfaces falling into this prefix

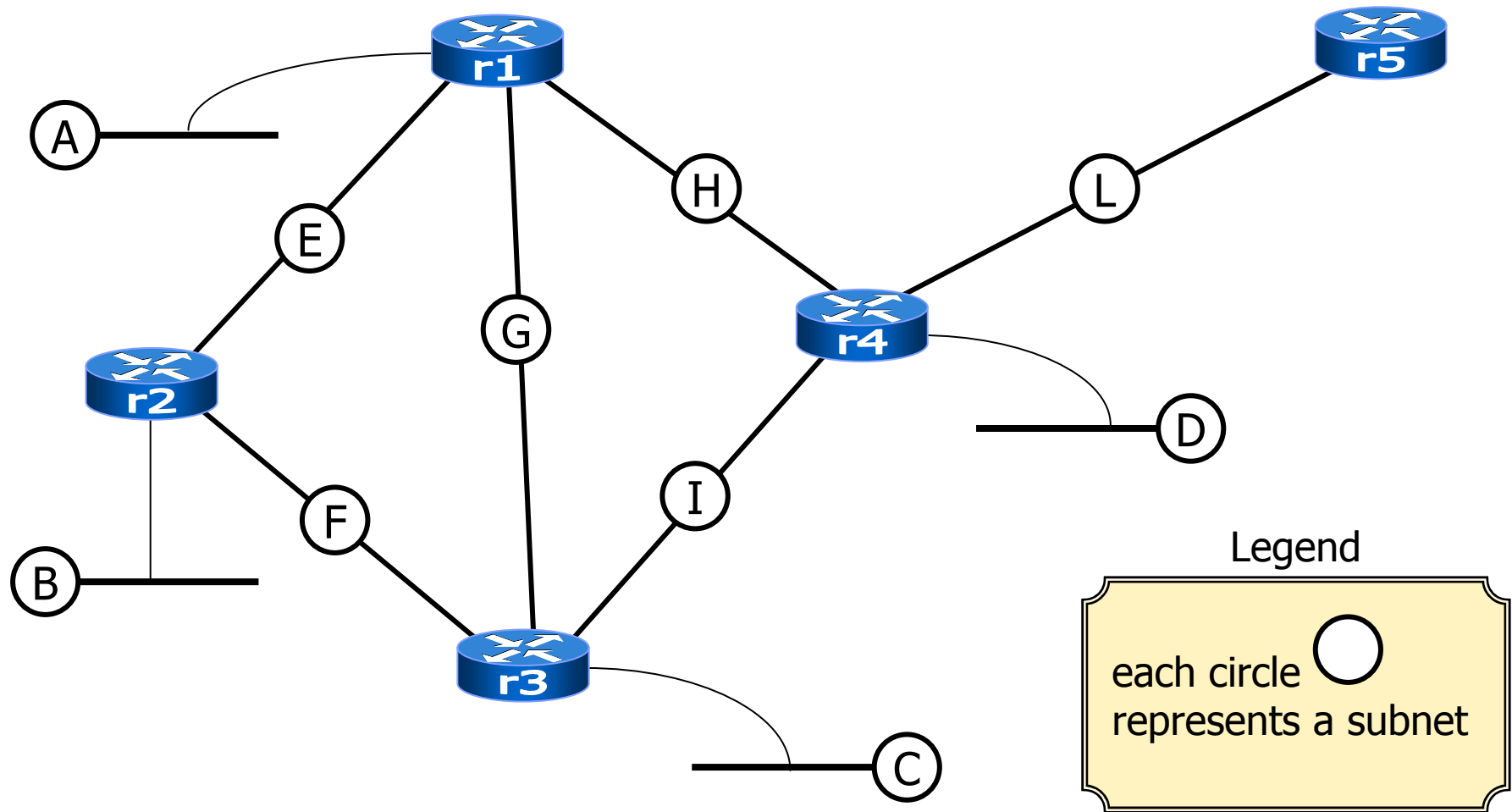
# about `redistribute connected`

- 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

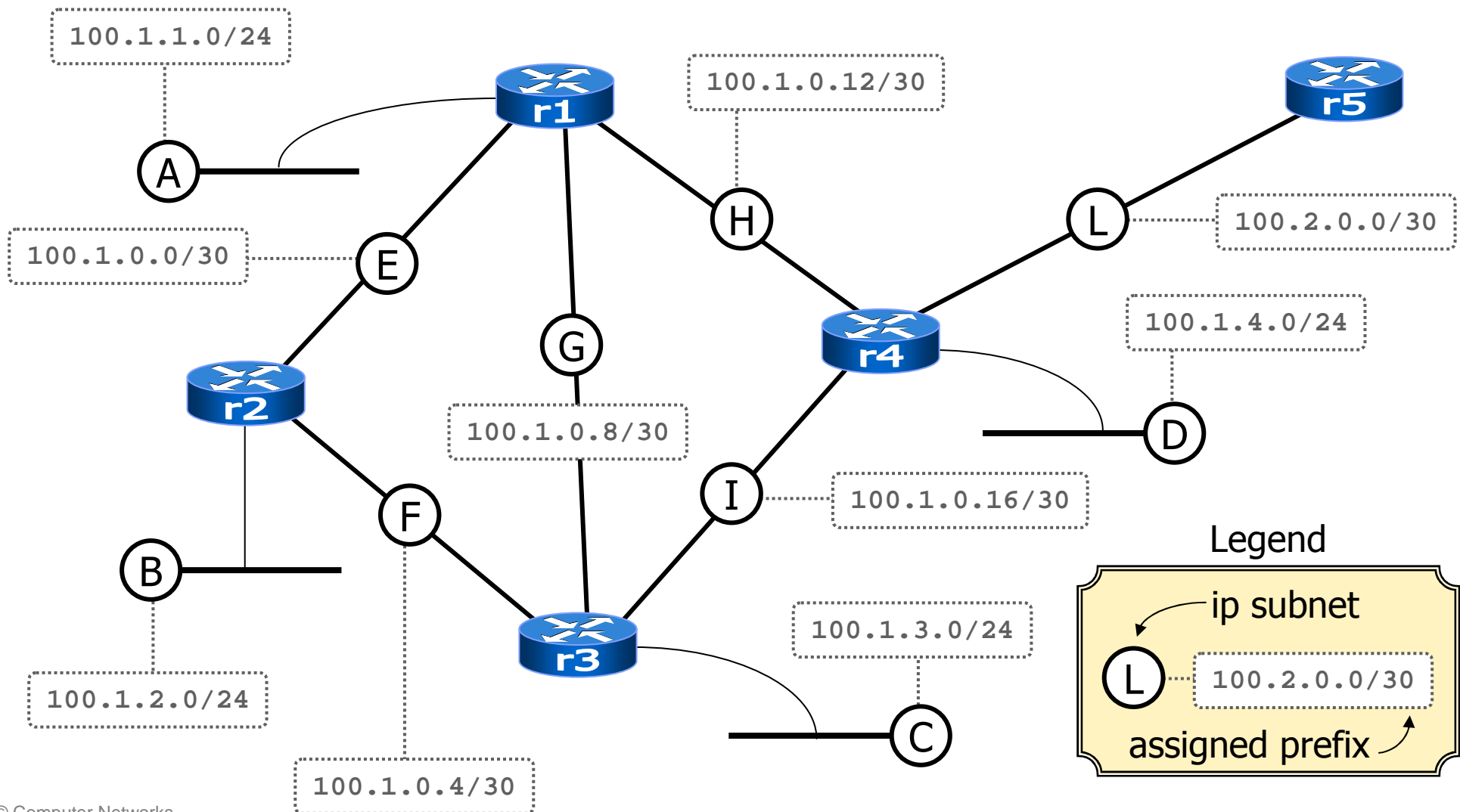
# a small network connected to the Internet



# the involved ip subnets

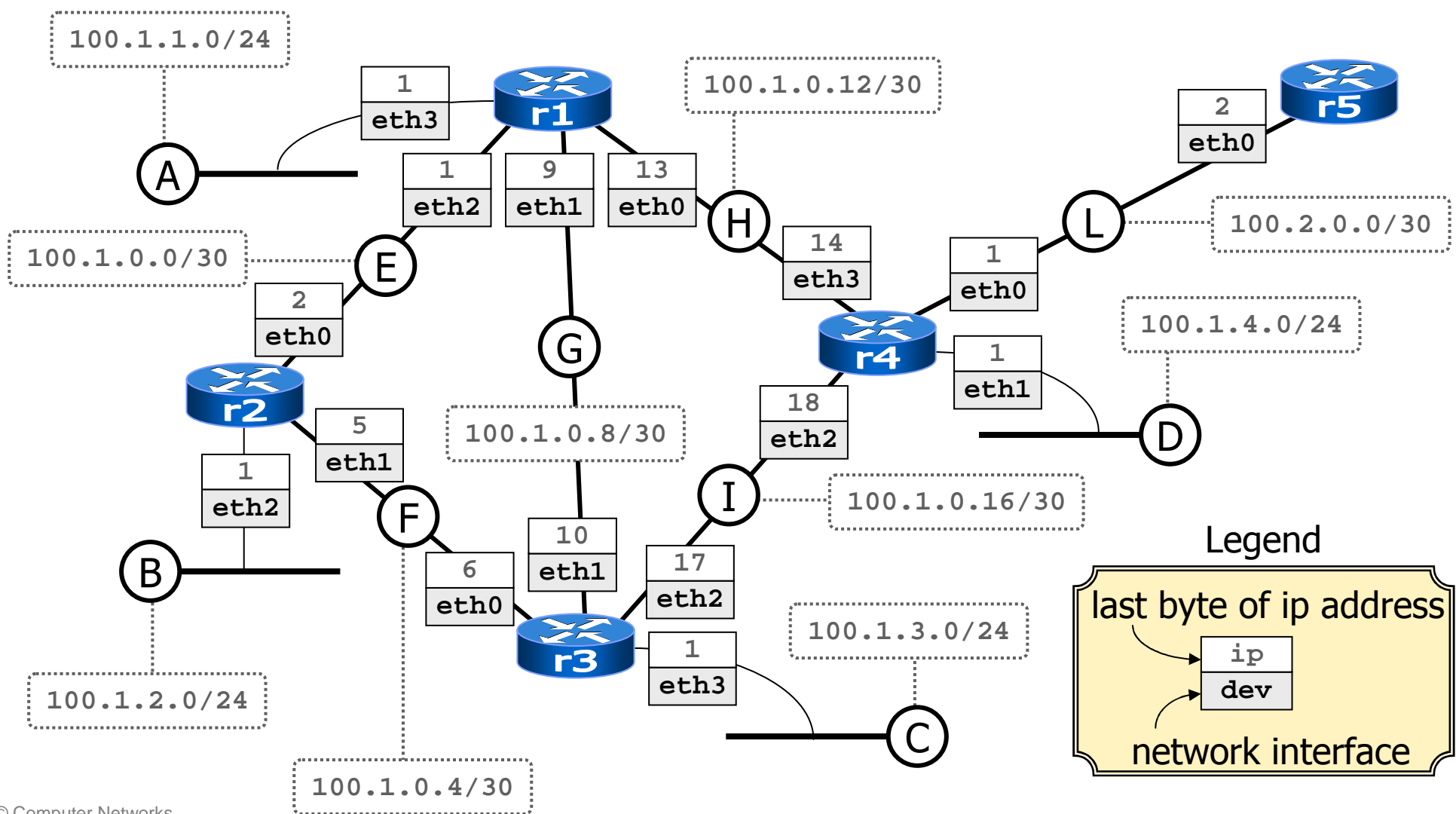


# assigning ip numbers to subnets

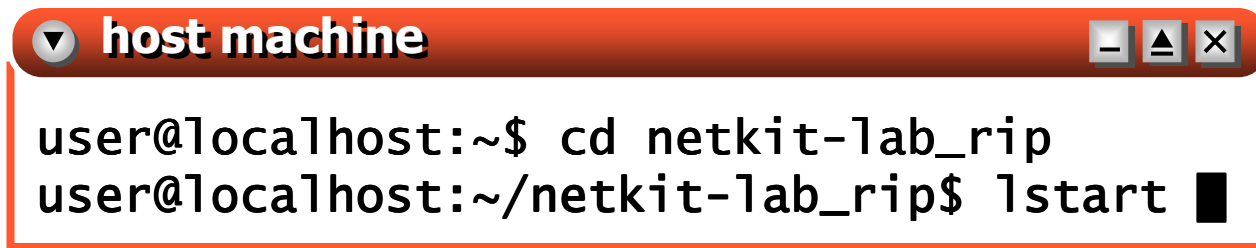




# assigning ip numbers to interfaces



# 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
    - configuration files `/etc/zebra/daemons`, `/etc/zebra/zebra.conf`, and `/etc/zebra/ripd.conf` are updated
  - the zebra routing daemon is not automatically started

# checking connectivity

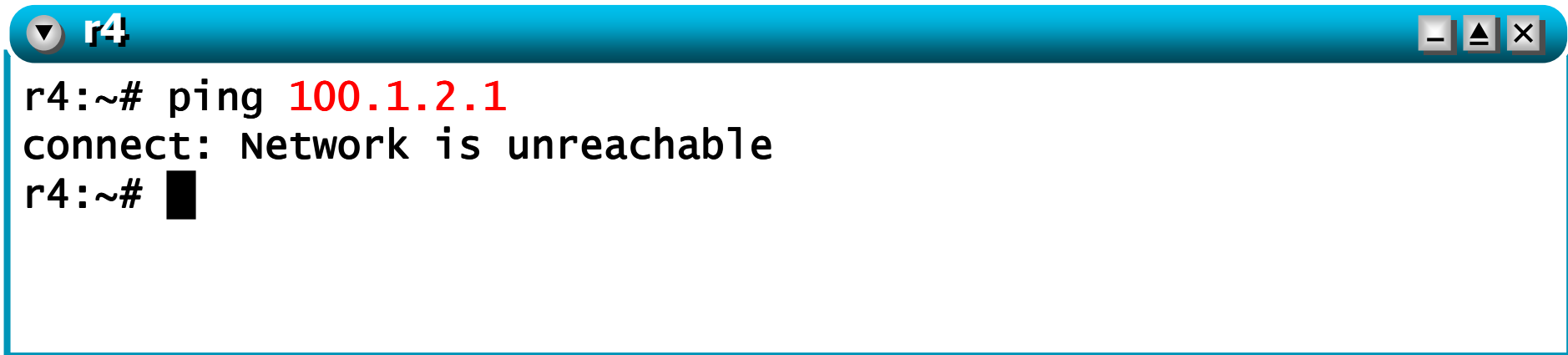
- towards a directly connected destination

```
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

A terminal window titled 'r4' with standard window controls (minimize, maximize, close) in the top right corner. The terminal text shows a user at the 'r4' prompt typing 'ping 100.1.2.1'. The output is 'connect: Network is unreachable', followed by a new prompt 'r4:~#' and a black square cursor.

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

- what's going on?

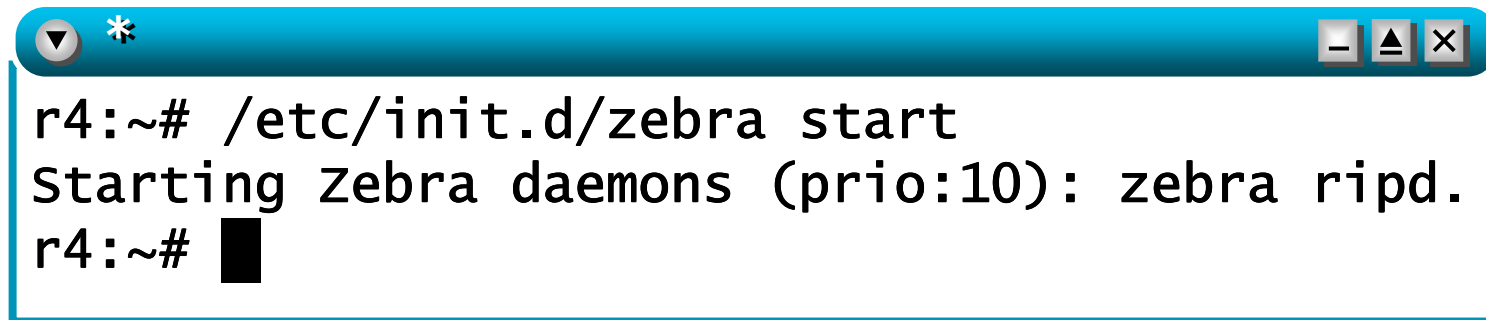
# examining the kernel routing table

```
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

# starting the routing daemons

- on each router (but `r5`) issue the following command:

A terminal window with a blue title bar containing a dropdown arrow, an asterisk, and window control buttons (minimize, maximize, close). The terminal text shows the command to start Zebra daemons on router r4.

```
r4:~# /etc/init.d/zebra start
Starting Zebra daemons (prio:10): zebra ripd.
r4:~# █
```

# checking connectivity (again)

- towards a remote destination

```
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

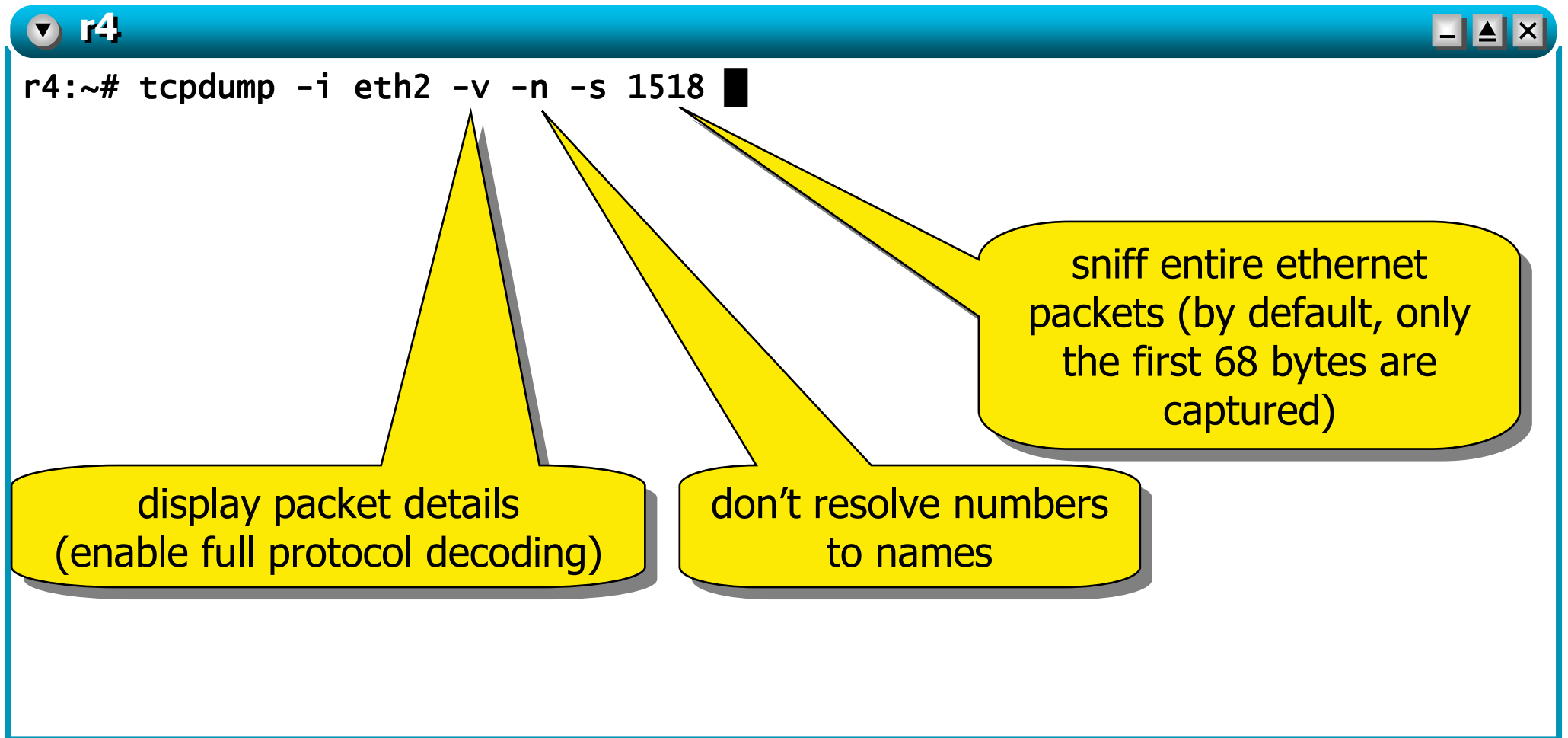
- the routing table is now updated

```
r4:~# 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



The image shows a terminal window titled 'r4' with the command `tcpdump -i eth2 -v -n -s 1518` entered. Three yellow callout boxes point to specific parts of the command: '-v' is explained as 'display packet details (enable full protocol decoding)', '-n' as 'don't resolve numbers to names', and '-s 1518' as 'sniff entire ethernet packets (by default, only the first 68 bytes are captured)'.

```
r4:~# tcpdump -i eth2 -v -n -s 1518
```

display packet details  
(enable full protocol decoding)

don't resolve numbers  
to names

sniff entire ethernet  
packets (by default, only  
the first 68 bytes are  
captured)

# a look at ripv2 packets

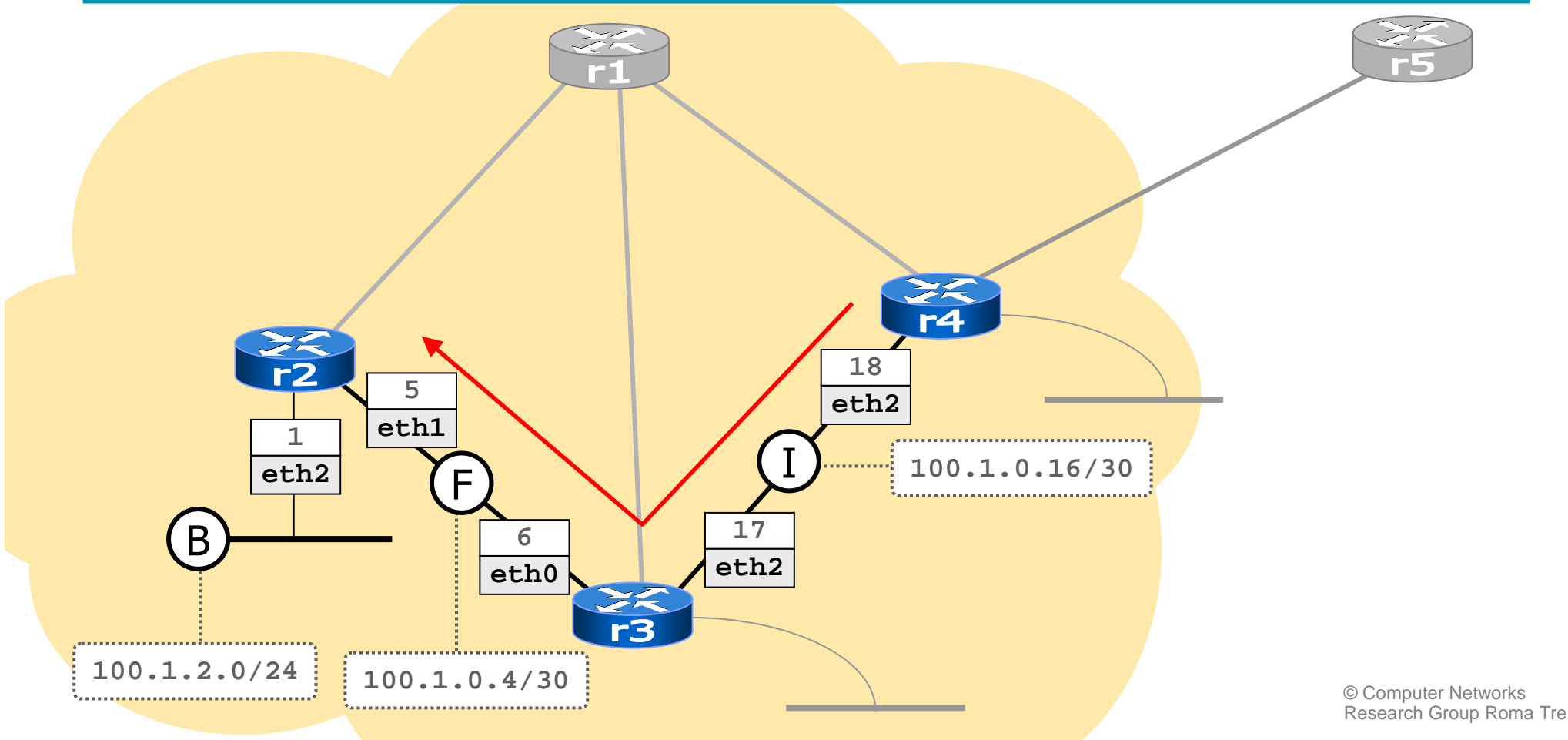
- let's sniff ripv2 packets

```
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:~# 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,
```

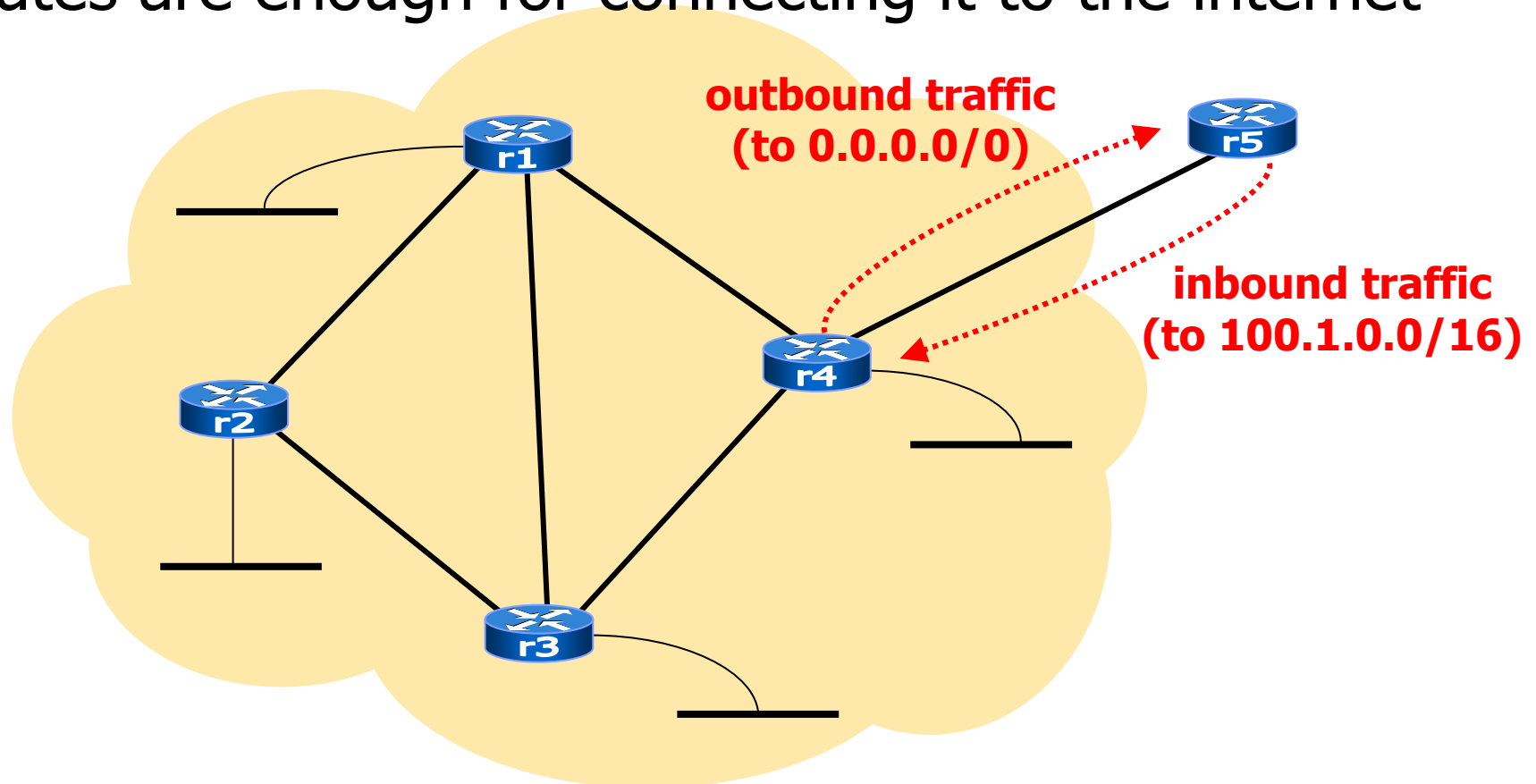
```
(i) - interface
```

	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

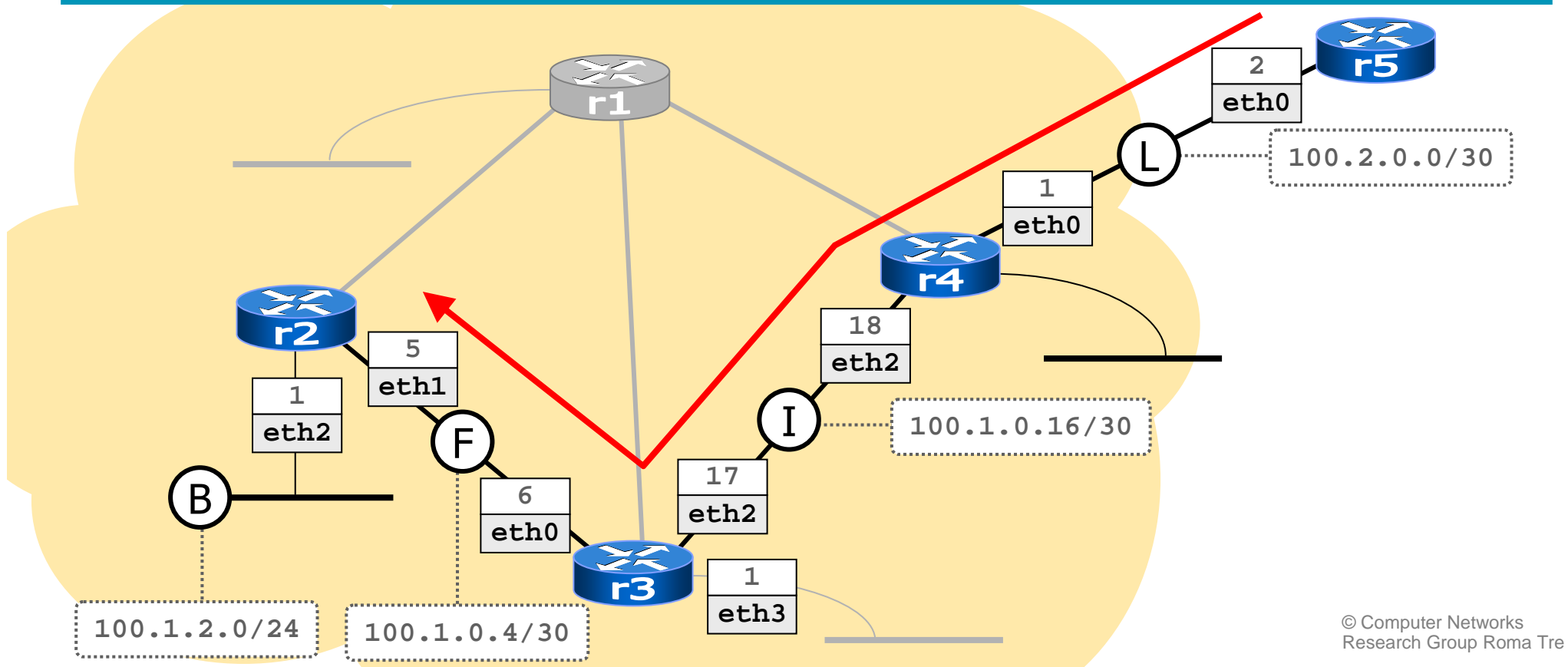
```
r5:~# route add -net 100.1.0.0/16 gw 100.2.0.1
r5:~# ping 100.1.2.1
PING 100.1.2.1 (100.1.2.1) 56(84) bytes of data.
64 bytes from 100.1.2.1: icmp_seq=1 ttl=62 time=24.1 ms
64 bytes from 100.1.2.1: icmp_seq=2 ttl=62 time=1.11 ms

--- 100.1.2.1 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1023ms
rtt min/avg/max/mdev = 1.117/12.634/24.151/11.517 ms
r5:~# █
```

# 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:~# █
```



# 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

The image shows a terminal window titled 'r4' with a blue header bar containing a dropdown arrow, the text 'r4', and window control buttons (minimize, maximize, close). The terminal output is as follows:

```
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
```

Annotations on the right side of the terminal window, connected to the terminal text by lines, are:

- work as a privileged user (green box) - points to the 'enable' command.
- begin configuration (yellow box) - points to the 'configure terminal' command.
- configure the rip protocol (pink box) - points to the 'router rip' command.
- statically configure the default route (pink box) - points to the 'route 0.0.0.0/0' command.
- end of rip configuration (pink box) - points to the first 'quit' command.
- end configuration (pink box) - points to the second 'quit' command.
- abandon privileges (yellow box) - points to the 'disable' command.

# 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

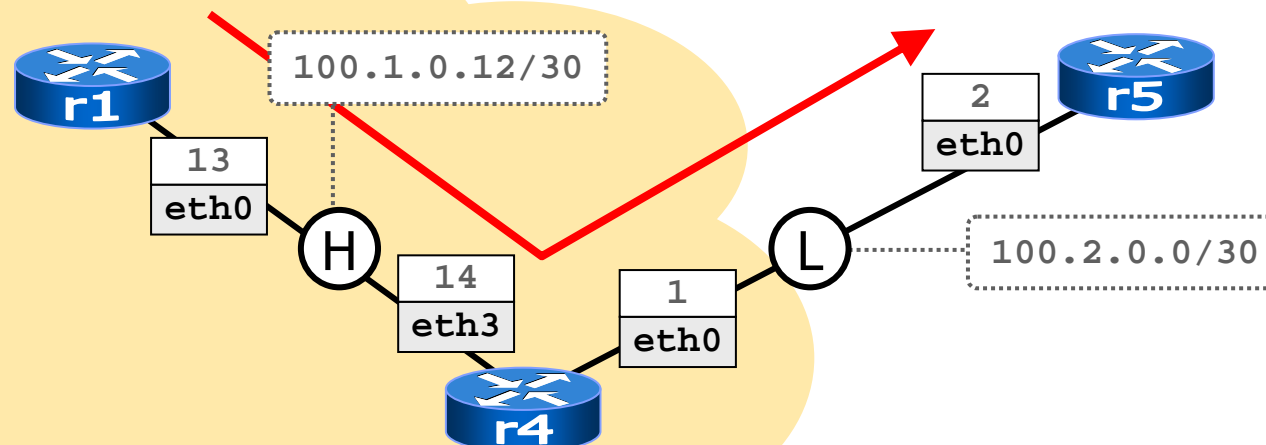
▼ r1

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

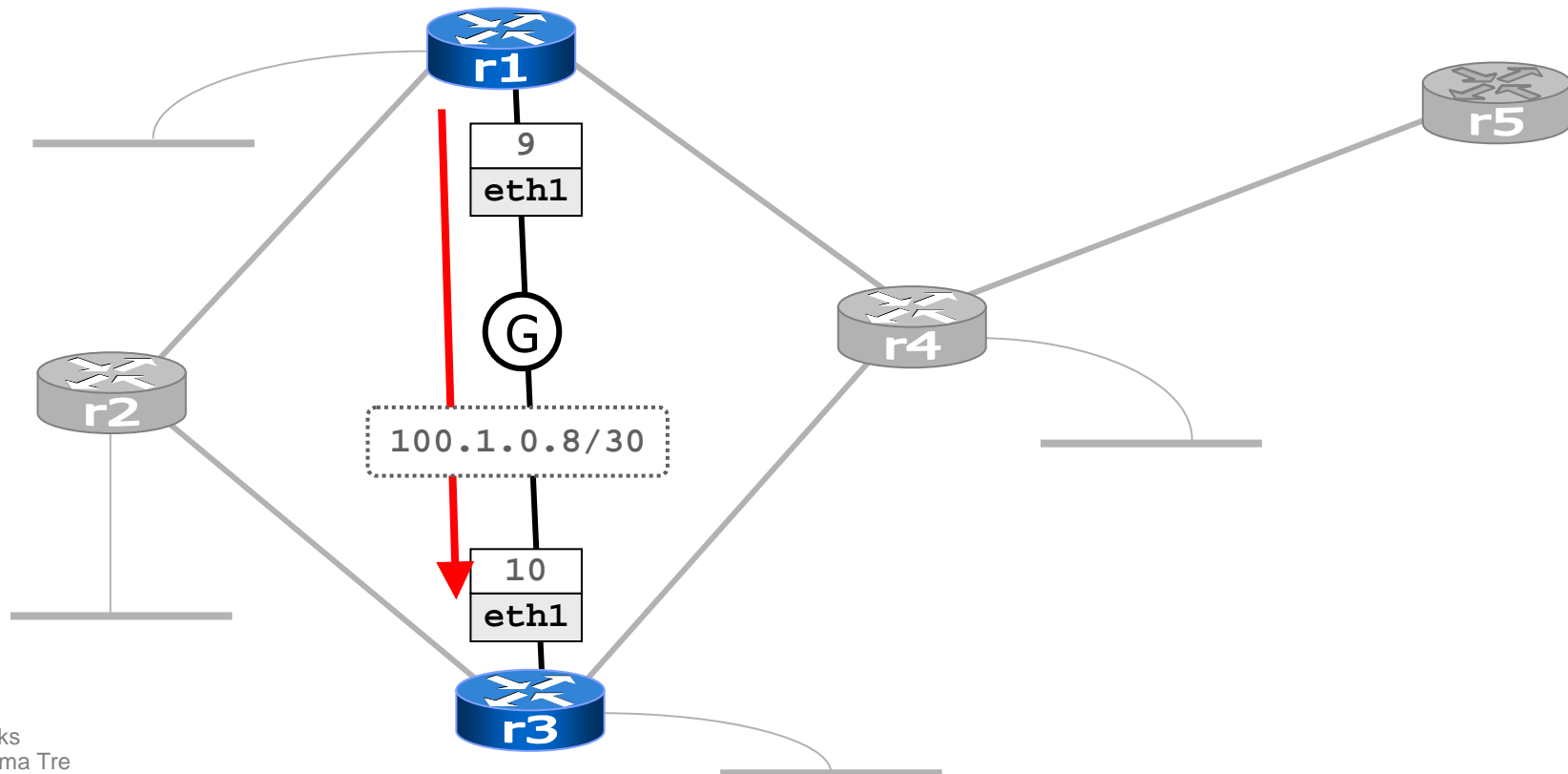
```
r5:~# tcpdump -i eth0 -n -s 1518
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 1518 bytes
11:38:43.822503 arp who-has 100.2.0.2 tell 100.2.0.1
11:38:43.824221 arp reply 100.2.0.2 is-at fe:fd:64:02:00:02
11:38:43.825890 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:~# █
```

# shutting down an interface

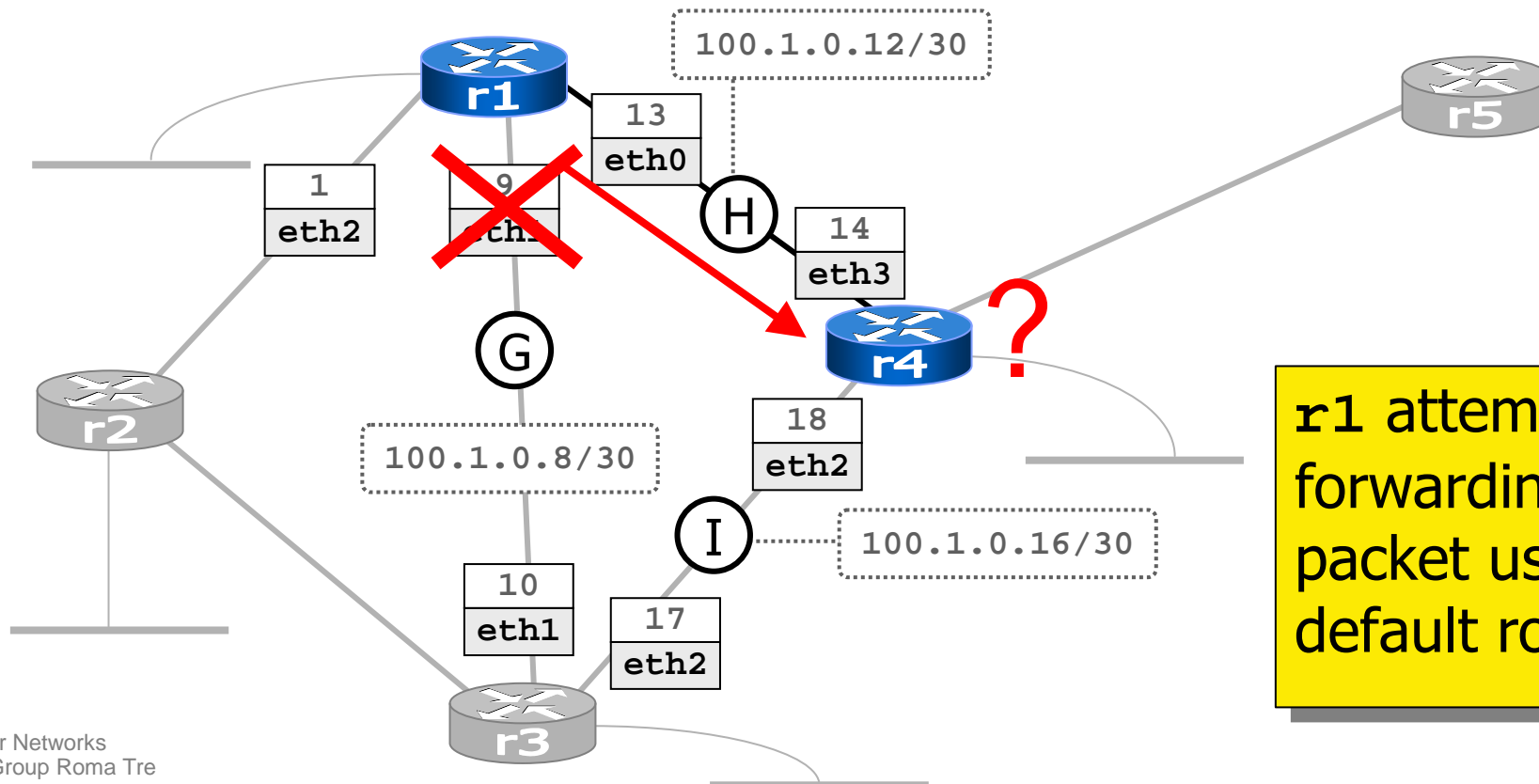
▼ r1

```
r1:~# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
 1 100.1.0.10 (100.1.0.10) 24 ms 1 ms 1 ms
r1:~# ifconfig eth1 down
```



# shutting down an interface

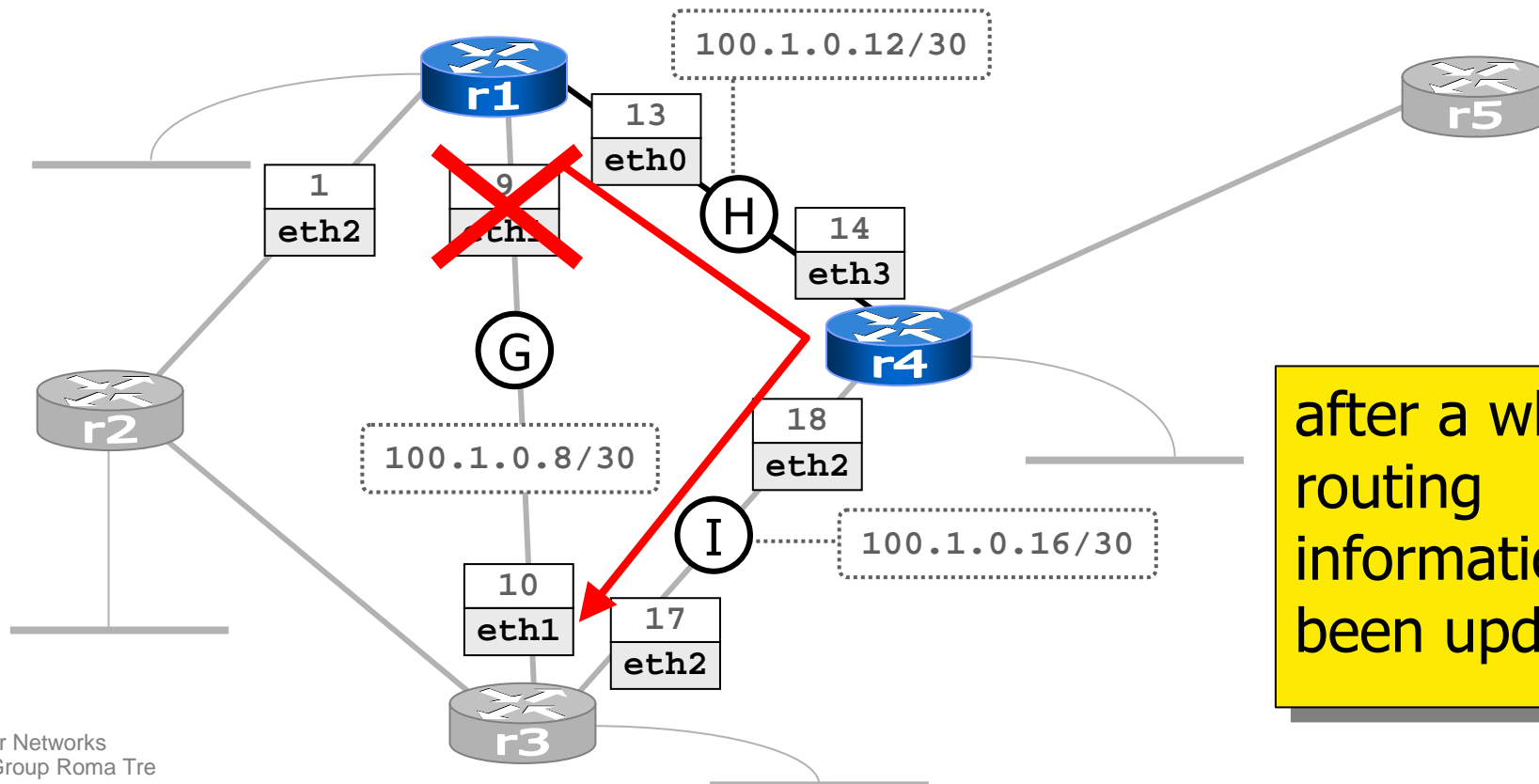
```
r1
r1:~# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
 1  100.1.0.14 (100.1.0.14)  1 ms  1 ms  1 ms
 2  * * *
 3  * * * █
```



# 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  100.1.0.10 (100.1.0.10)  5 ms  2 ms  1 ms
r1:~# █
```



# 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:~#
```