Università degli Studi Roma Tre
Dipartimento di Ingegneria
Computer Networks Research Group

kathara lab

rip with FRRouting

Version	1.0
Author(s)	G. Di Battista, M. Patrignani, M. Pizzonia, L. Ariemma, M. Scazzariello, T. Caiazzi
E-mail	contact@kathara.org
Web	http://www.kathara.org/
Description	experiences with the ripv2 distance vector routing protocol – derives from kathara rip lab ver. 1.2 which, in turns, derives from netkit rip lab ver. 2.4

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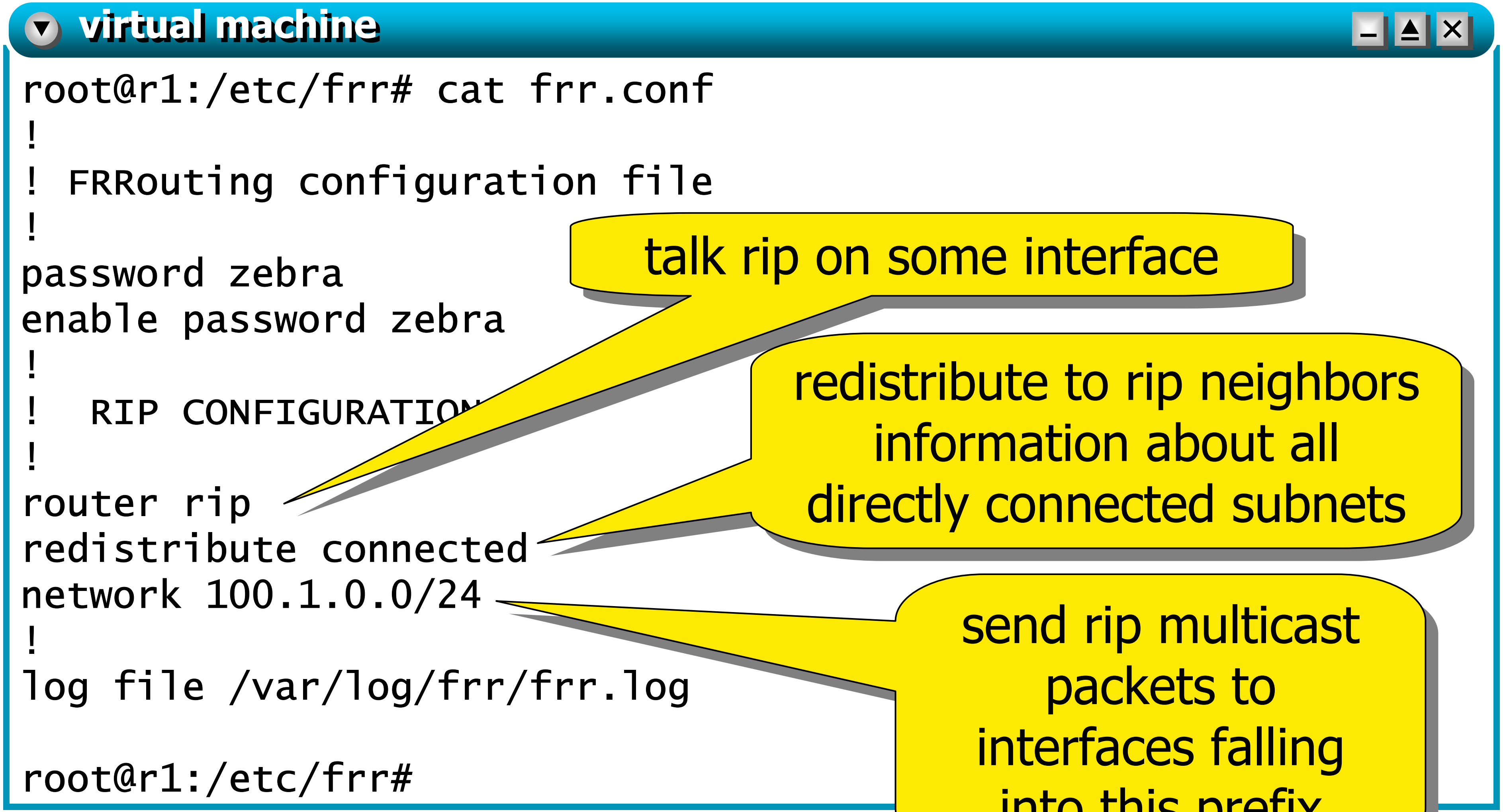
routing protocols

- 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 frr boxes

sample `frr.conf` configuration file



```
root@r1:/etc/frr# cat frr.conf
!
! FRRouting configuration file
!
password zebra
enable password zebra
!
!  RIP CONFIGURATION
!
router rip
redistribute connected
network 100.1.0.0/24
!
log file /var/log/frr/frr.log

root@r1:/etc/frr#
```

talk rip on some interface

redistribute to rip neighbors information about all directly connected subnets

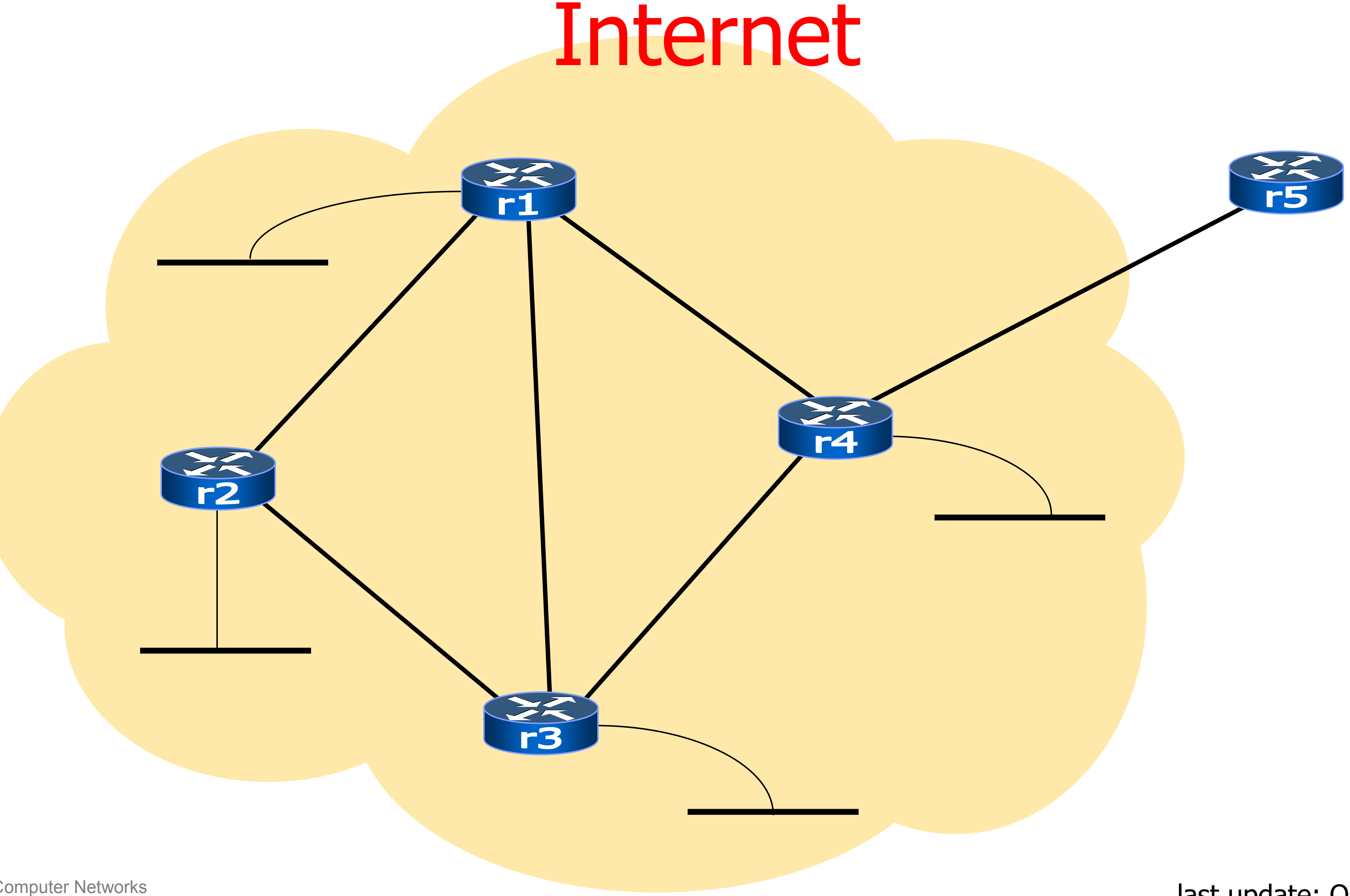
send rip multicast packets to interfaces falling into this prefix

about `redistribute connected`

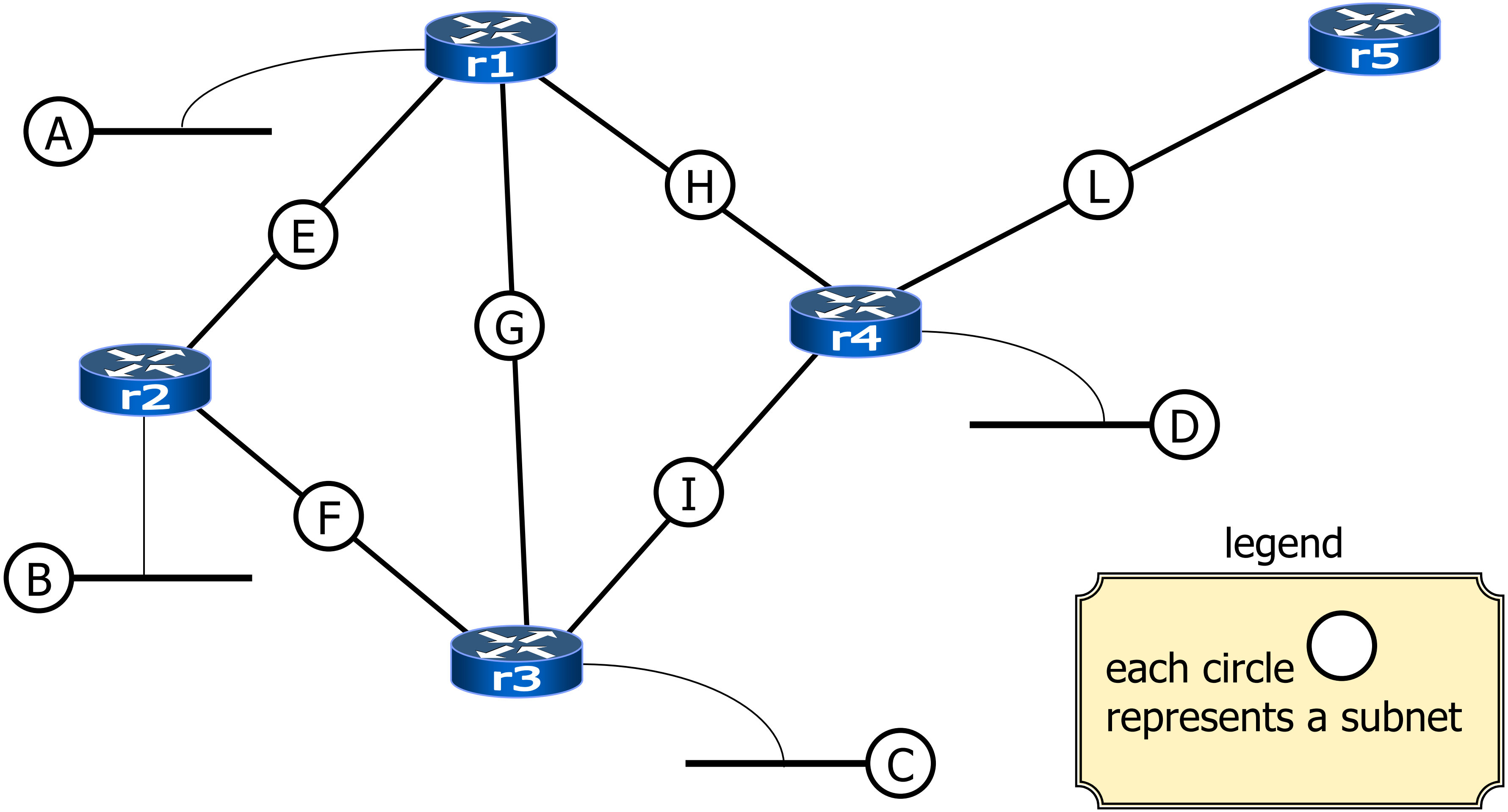
- by default (i.e., without further configuration) RIP already propagates information about directly connected subnets...
  ...attached to RIP-speaking interfaces only
- `redistribute connected` forces RIP to propagate information about all connected subnets

- 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



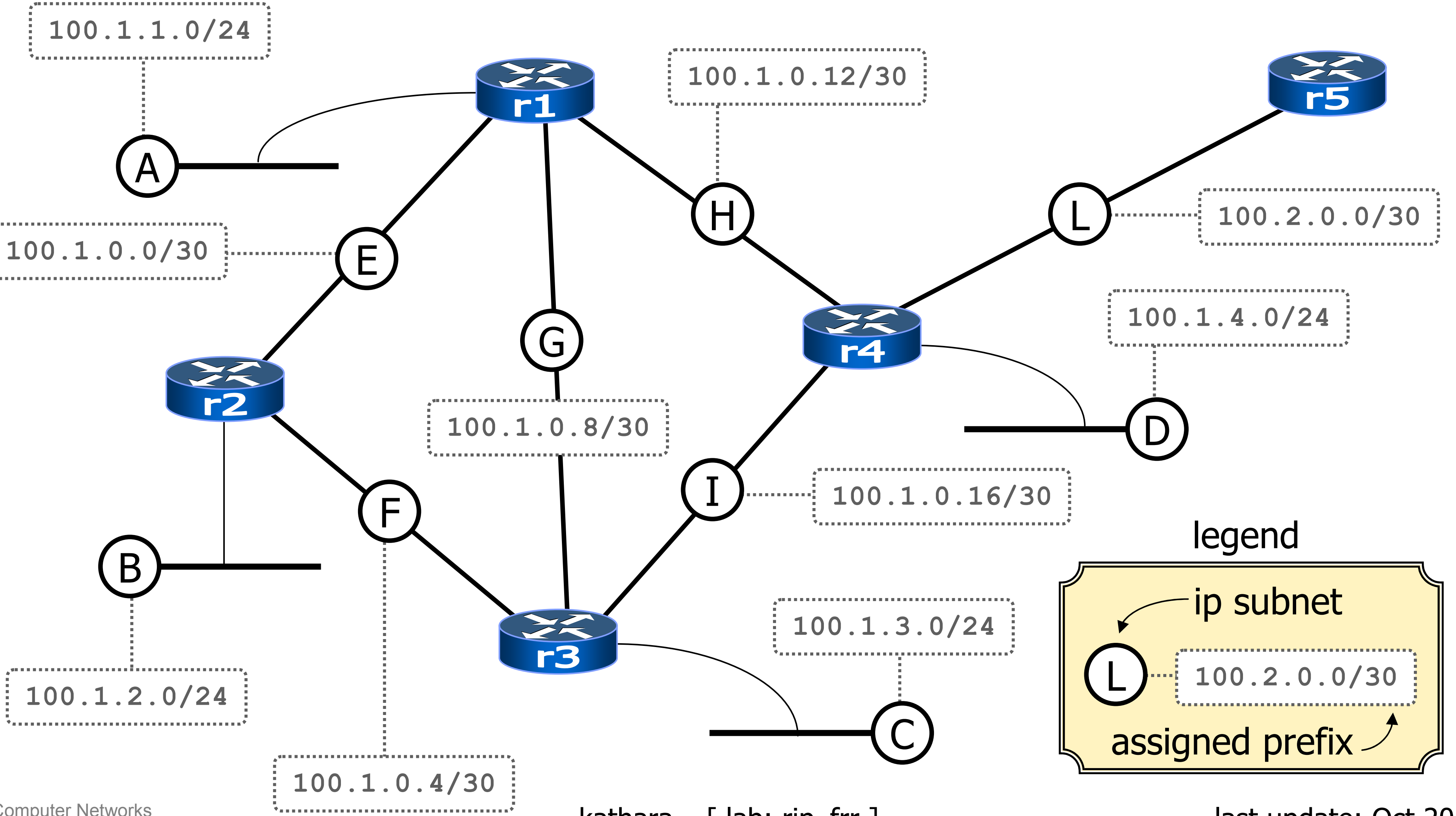
the involved ip subnets



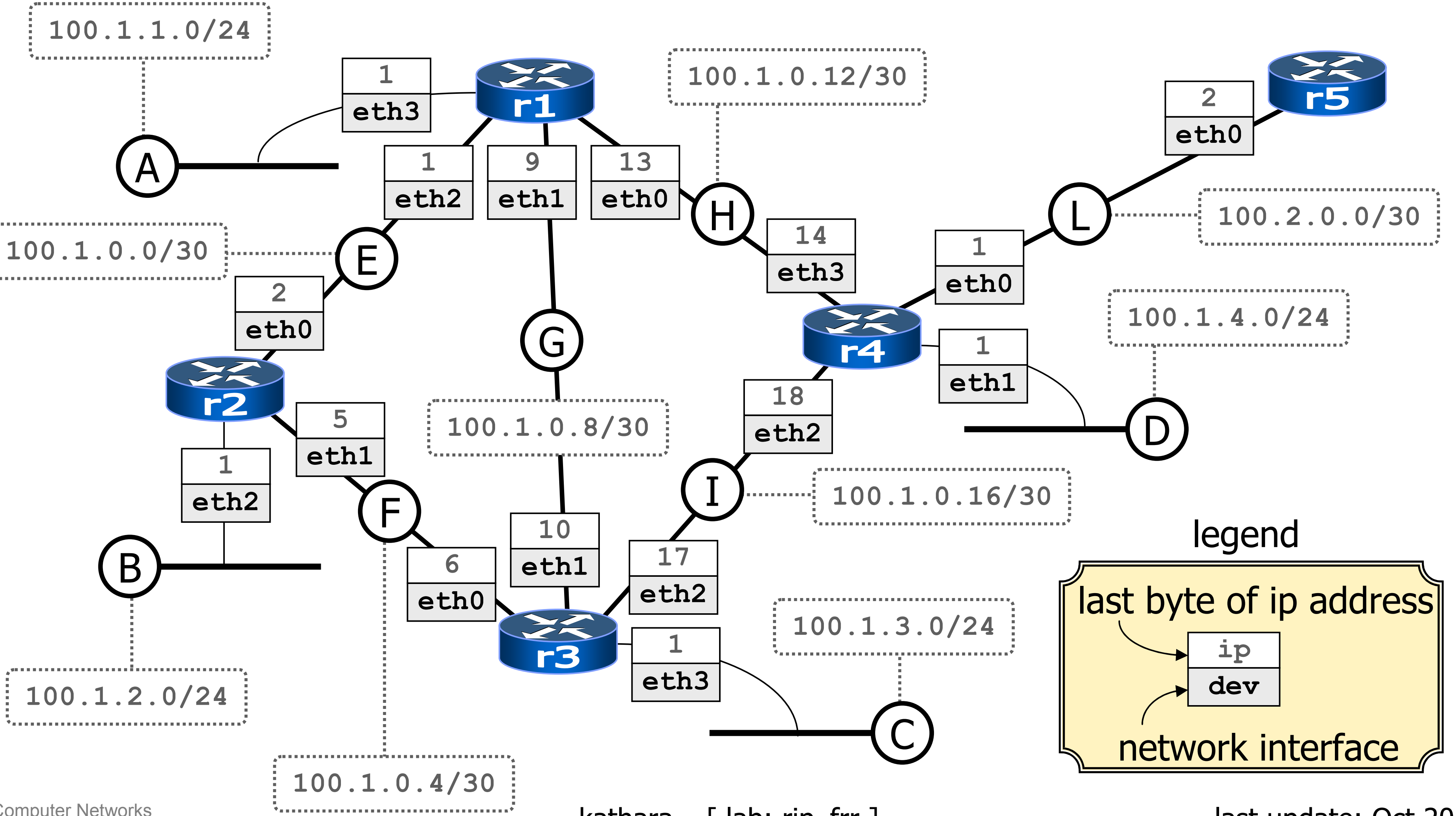
legend

each circle ○ represents a subnet

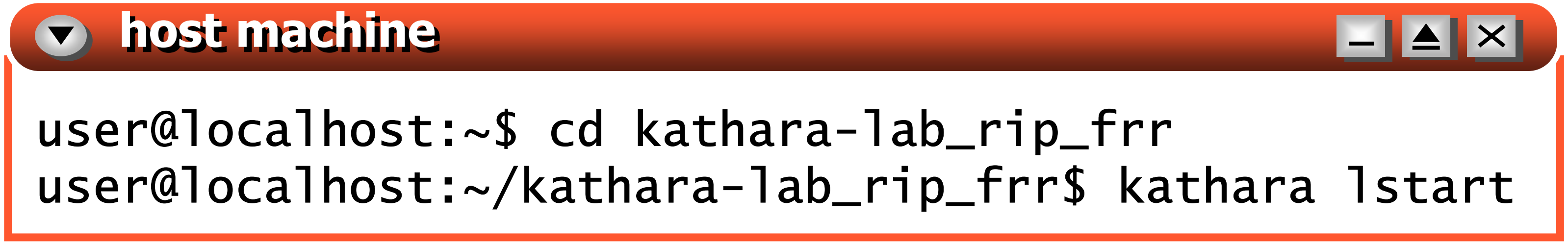
assigning ip numbers to subnets



assigning ip numbers to interfaces



launching the lab script

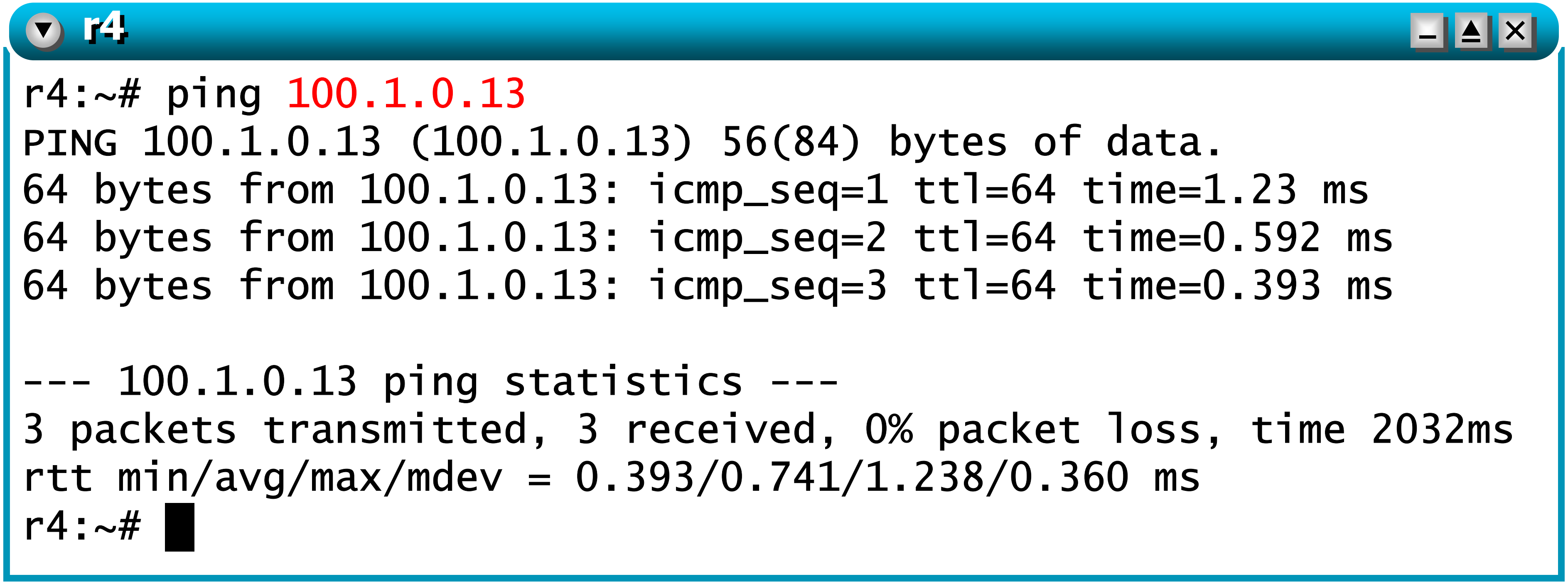


```
user@localhost:~$ cd kathara-lab_rip_frr
user@localhost:~/kathara-lab_rip_frr$ kathara lstart
```

- 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/frr/vtysh.conf`**, **`/etc/frr/daemons`**, and **`/etc/frr/frr.conf`** are updated
  - the frr routing daemon is not automatically started

checking connectivity

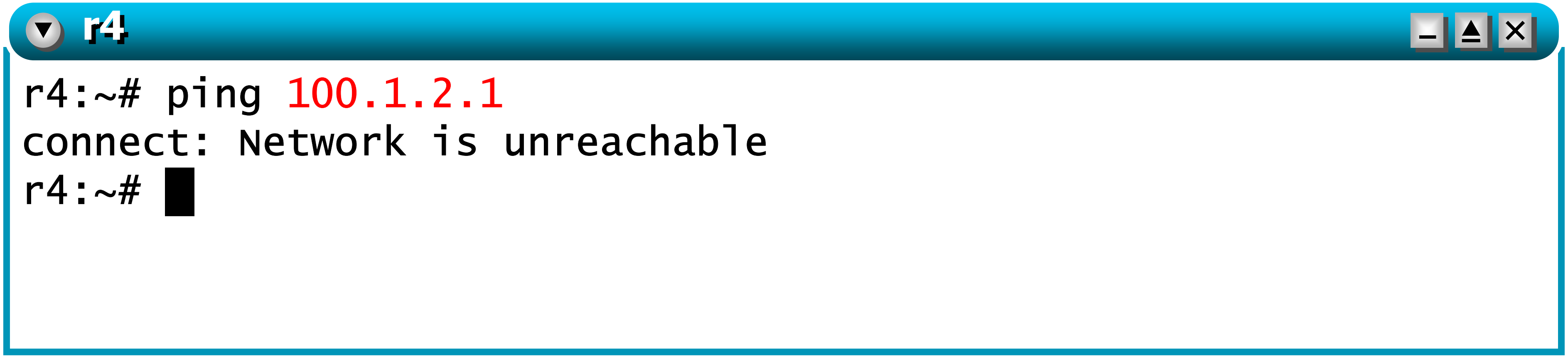
- towards a directly connected destination



```
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

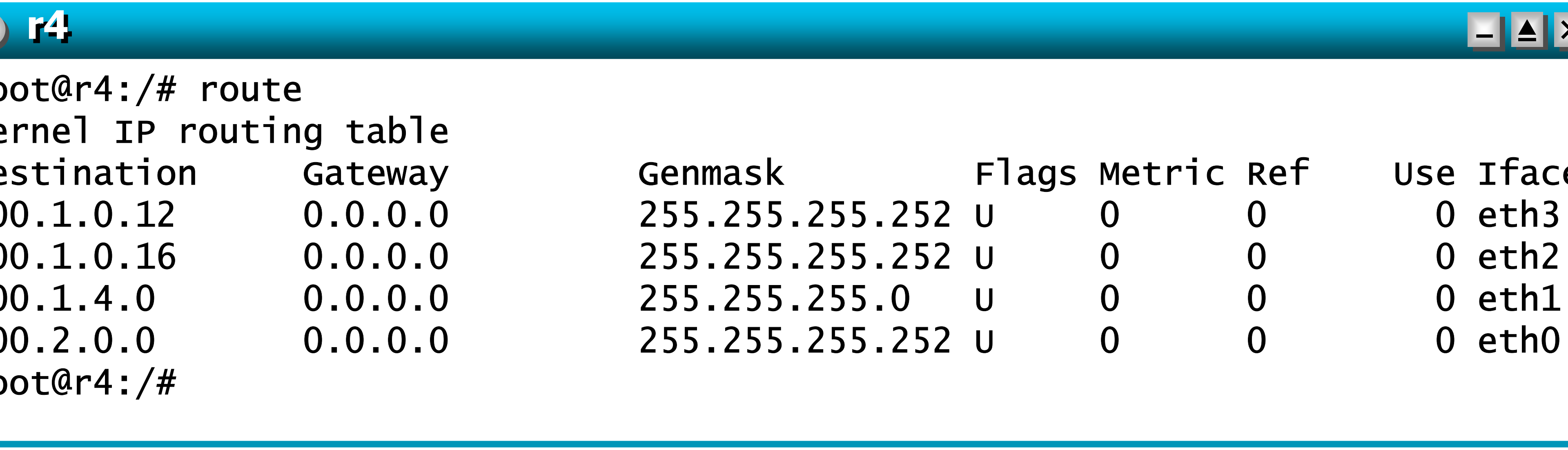
- towards a remote destination



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

- what’s going on?

examining the kernel routing table

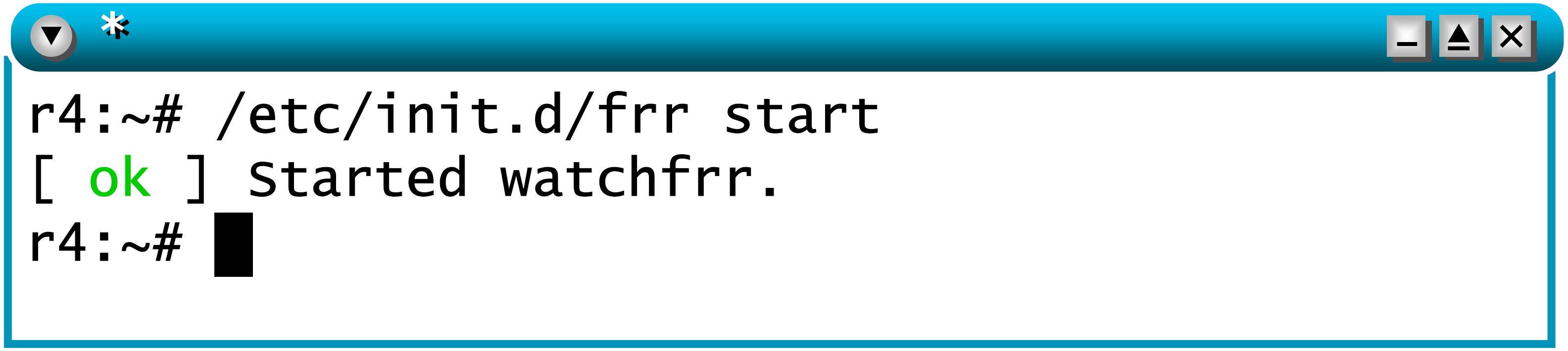


```
oot@r4:/# route
ernel IP routing table
estination     Gateway         Genmask         Flags Metric Ref    Use Iface
00.1.0.12      0.0.0.0         255.255.255.252 U     0      0        0 eth3
00.1.0.16      0.0.0.0         255.255.255.252 U     0      0        0 eth2
00.1.4.0       0.0.0.0         255.255.255.0   U     0      0        0 eth1
00.2.0.0       0.0.0.0         255.255.255.252 U     0      0        0 eth0
oot@r4:/#
```

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

starting the routing daemons

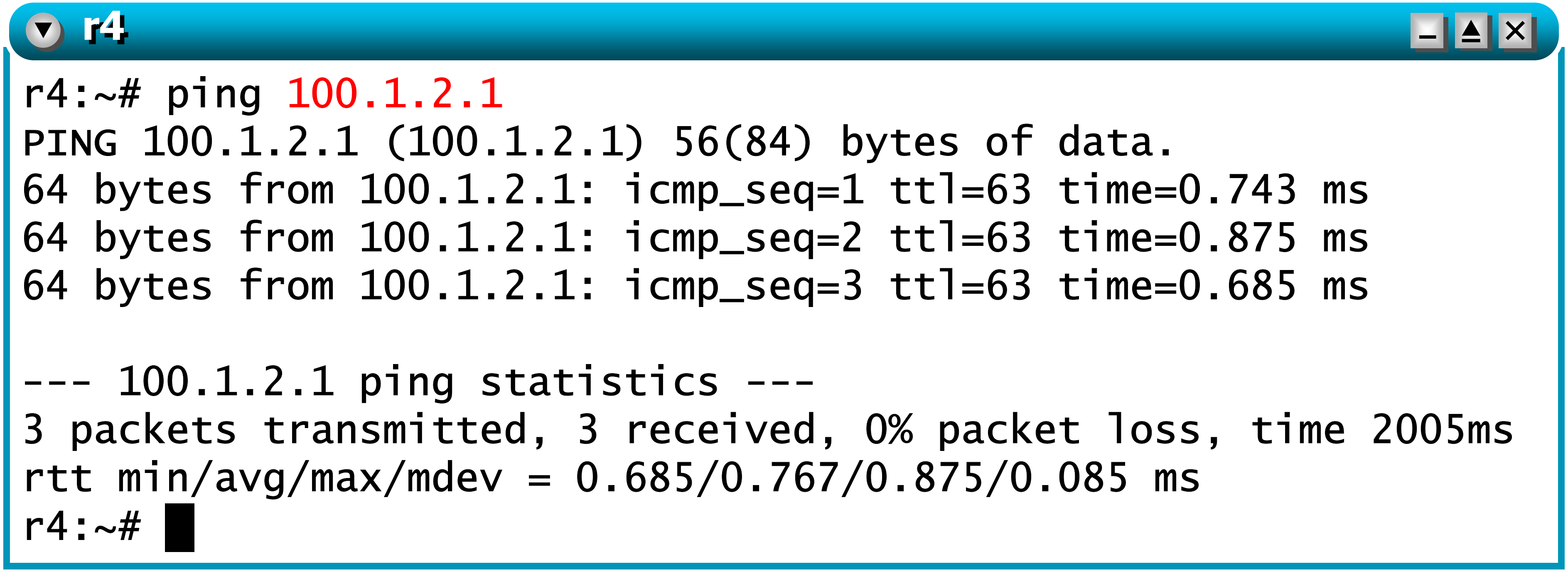
- on each router (but **`r5`**) issue the following command:



```
r4:~# /etc/init.d/frr start
[ ok ] Started watchfrr.
r4:~#
```

checking connectivity (again)

- towards a remote destination

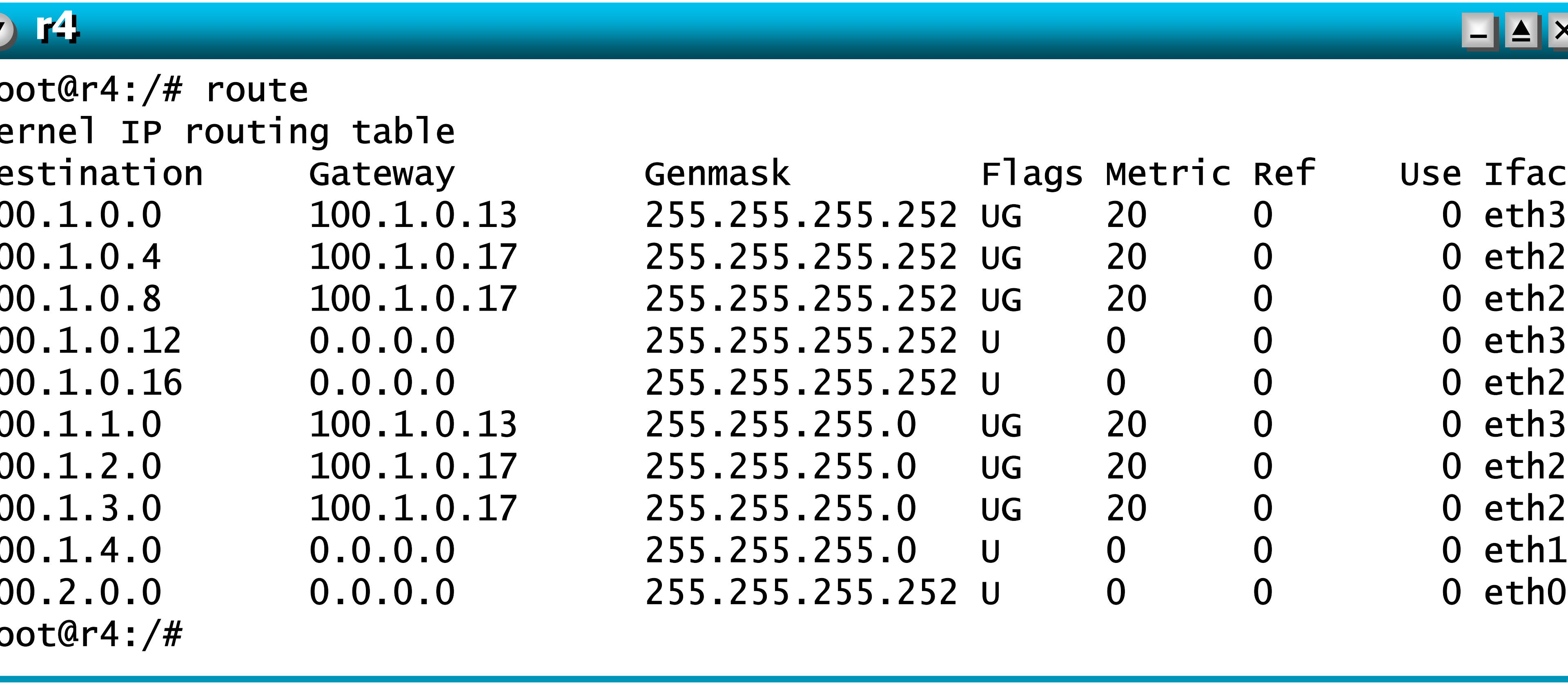


```
r4:~# ping 100.1.2.1
PING 100.1.2.1 (100.1.2.1) 56(84) bytes of data.
64 bytes from 100.1.2.1: icmp_seq=1 ttl=63 time=0.743 ms
64 bytes from 100.1.2.1: icmp_seq=2 ttl=63 time=0.875 ms
64 bytes from 100.1.2.1: icmp_seq=3 ttl=63 time=0.685 ms

--- 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

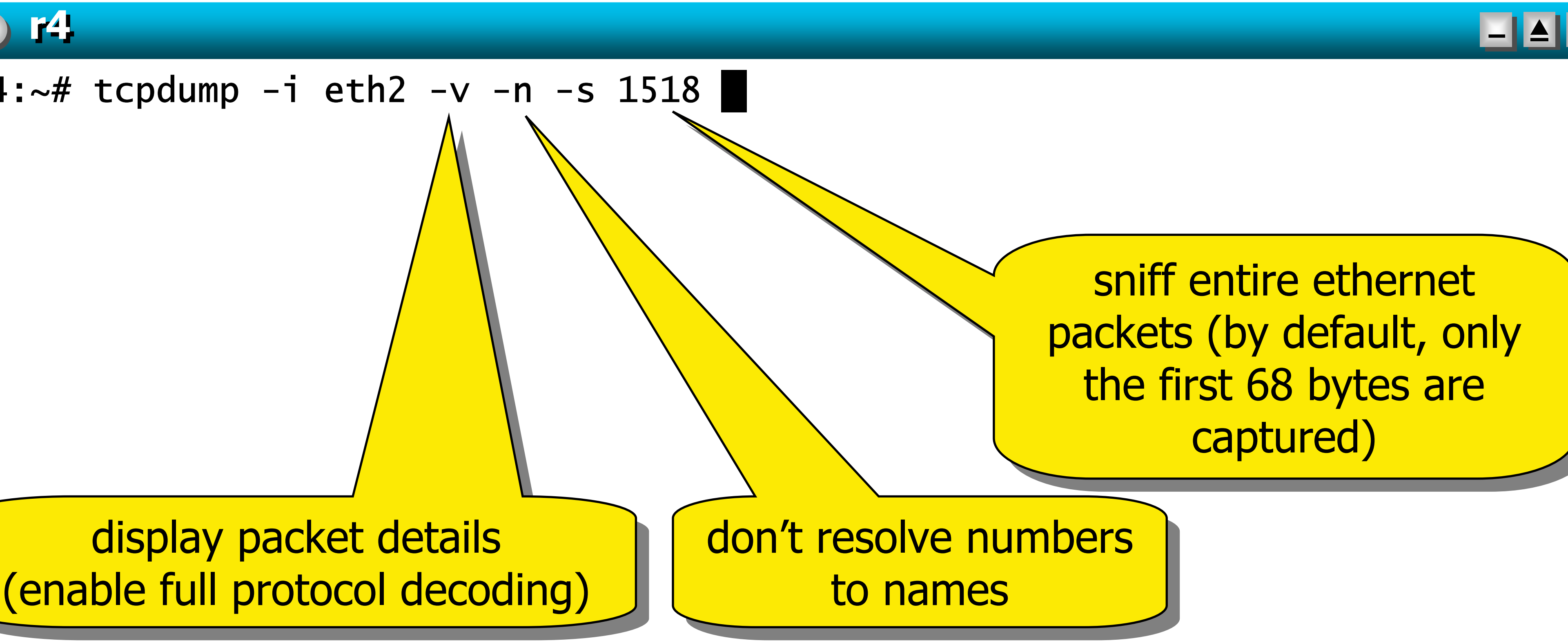
- the routing table is now updated



```
oot@r4:/# route
ernel IP routing table
estination     Gateway         Genmask         Flags Metric Ref    Use Ifac
00.1.0.0       100.1.0.13      255.255.255.252 UG    20     0        0 eth3
00.1.0.4       100.1.0.17      255.255.255.252 UG    20     0        0 eth2
00.1.0.8       100.1.0.17      255.255.255.252 UG    20     0        0 eth2
00.1.0.12      0.0.0.0         255.255.255.252 U     0      0        0 eth3
00.1.0.16      0.0.0.0         255.255.255.252 U     0      0        0 eth2
00.1.1.0       100.1.0.13      255.255.255.0   UG    20     0        0 eth3
00.1.2.0       100.1.0.17      255.255.255.0   UG    20     0        0 eth2
00.1.3.0       100.1.0.17      255.255.255.0   UG    20     0        0 eth2
00.1.4.0       0.0.0.0         255.255.255.0   U     0      0        0 eth1
00.2.0.0       0.0.0.0         255.255.255.252 U     0      0        0 eth0
oot@r4:/#
```

a look at ripv2 packets

- let’s sniff ripv2 packets



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

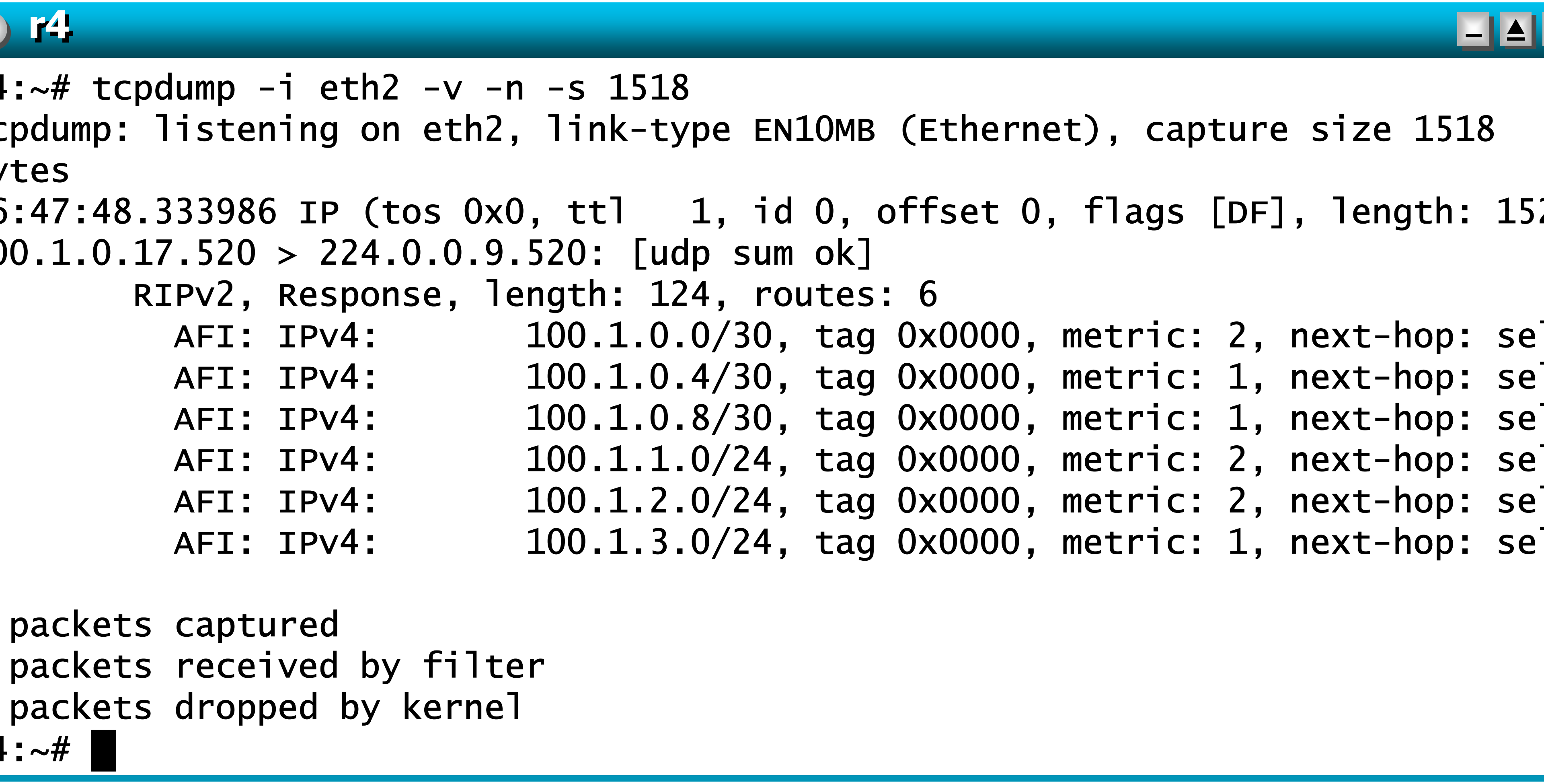
display packet details (enable full protocol decoding)

don’t resolve numbers to names

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

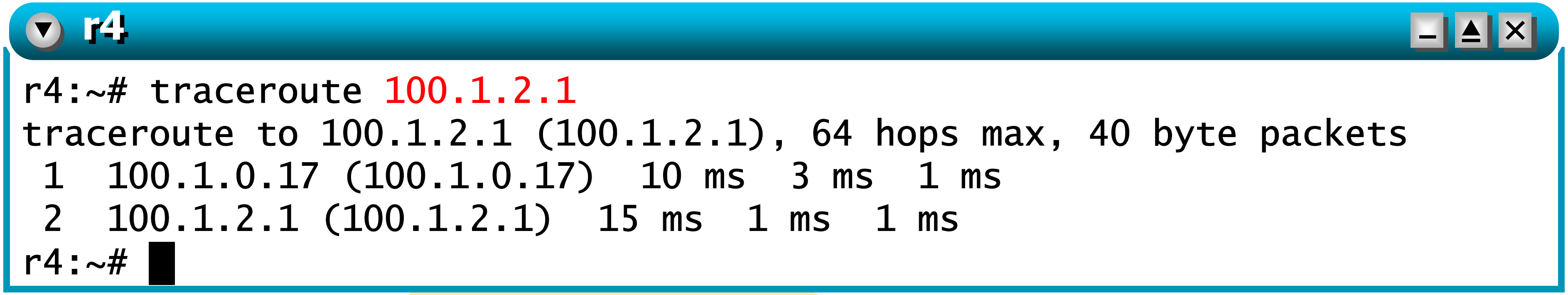
a look at ripv2 packets

- let’s sniff ripv2 packets

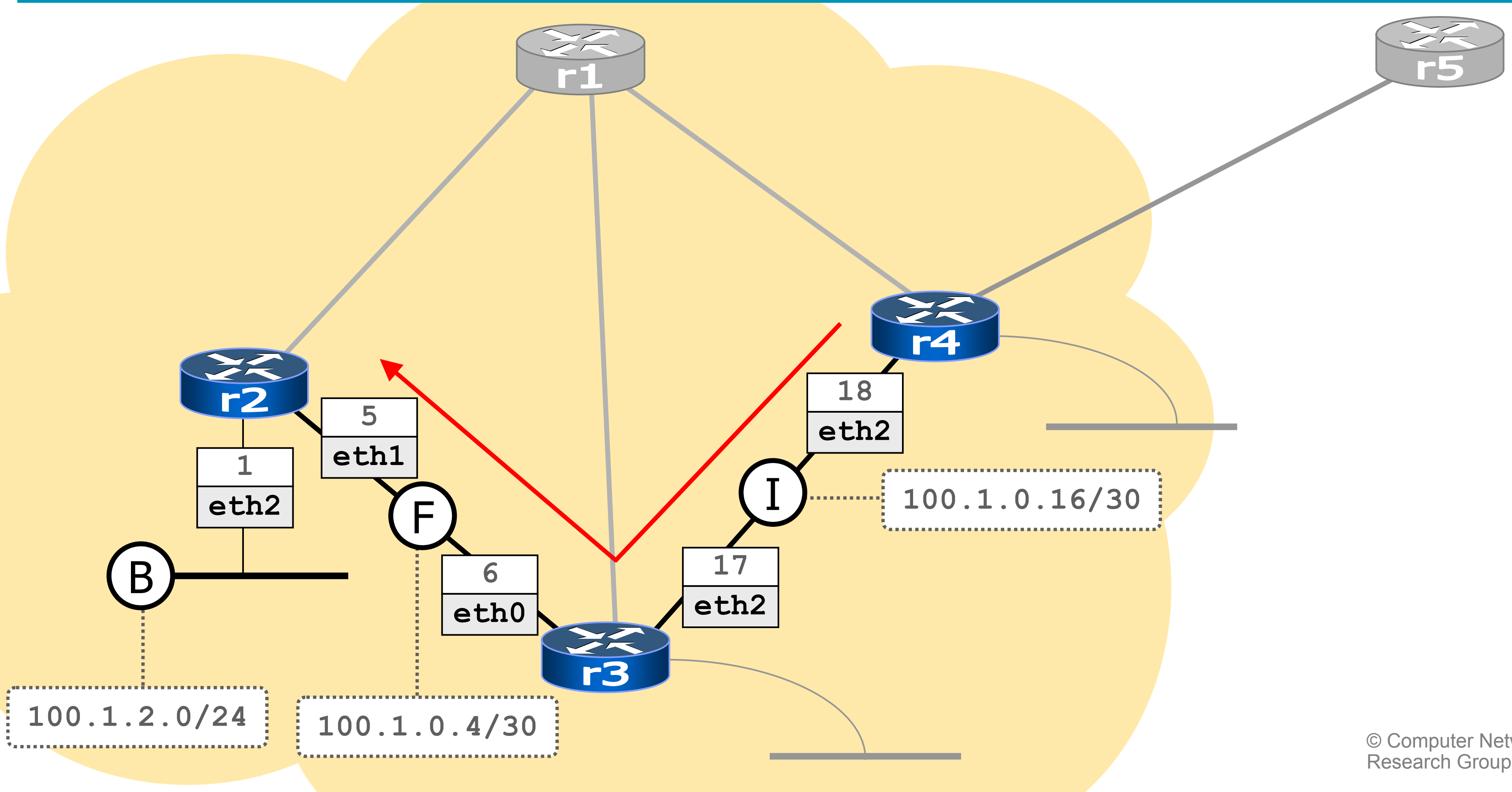


```
4:~# tcpdump -i eth2 -v -n -s 1518
cpdump: listening on eth2, link-type EN10MB (Ethernet), capture size 1518
ytes
6:47:48.333986 IP (tos 0x0, ttl   1, id 0, offset 0, flags [DF], length: 152
00.1.0.17.520 > 224.0.0.9.520: [udp sum ok]
      RIPv2, Response, length: 124, routes: 6
        AFI: IPv4:       100.1.0.0/30, tag 0x0000, metric: 2, next-hop: sel
        AFI: IPv4:       100.1.0.4/30, tag 0x0000, metric: 1, next-hop: sel
        AFI: IPv4:       100.1.0.8/30, tag 0x0000, metric: 1, next-hop: sel
        AFI: IPv4:       100.1.1.0/24, tag 0x0000, metric: 2, next-hop: sel
        AFI: IPv4:       100.1.2.0/24, tag 0x0000, metric: 2, next-hop: sel
        AFI: IPv4:       100.1.3.0/24, tag 0x0000, metric: 1, next-hop: sel

 packets captured
 packets received by filter
 packets dropped by kernel
4:~#
```

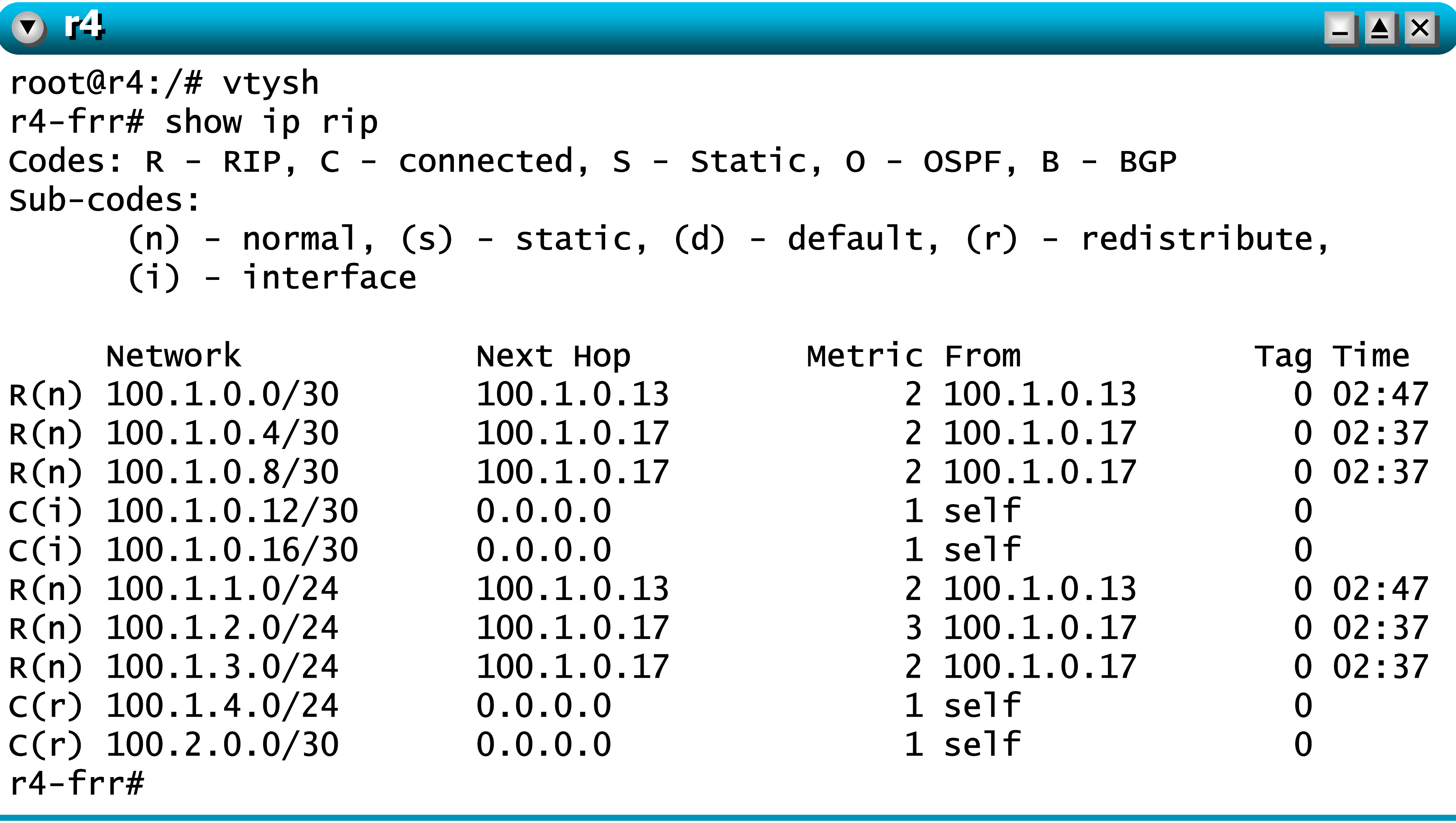
a traceroute



```
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:~#
```



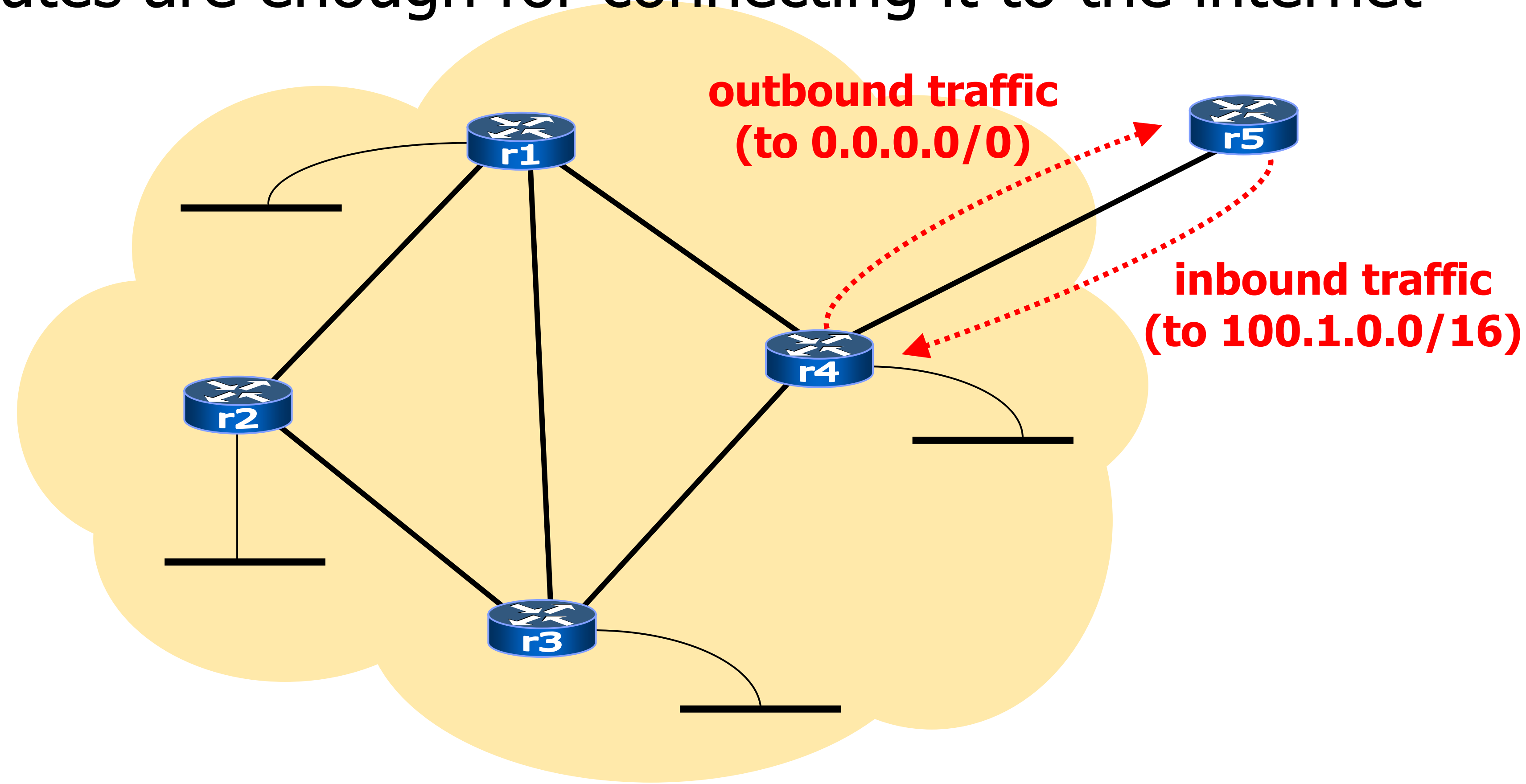
inspecting the rip routing table



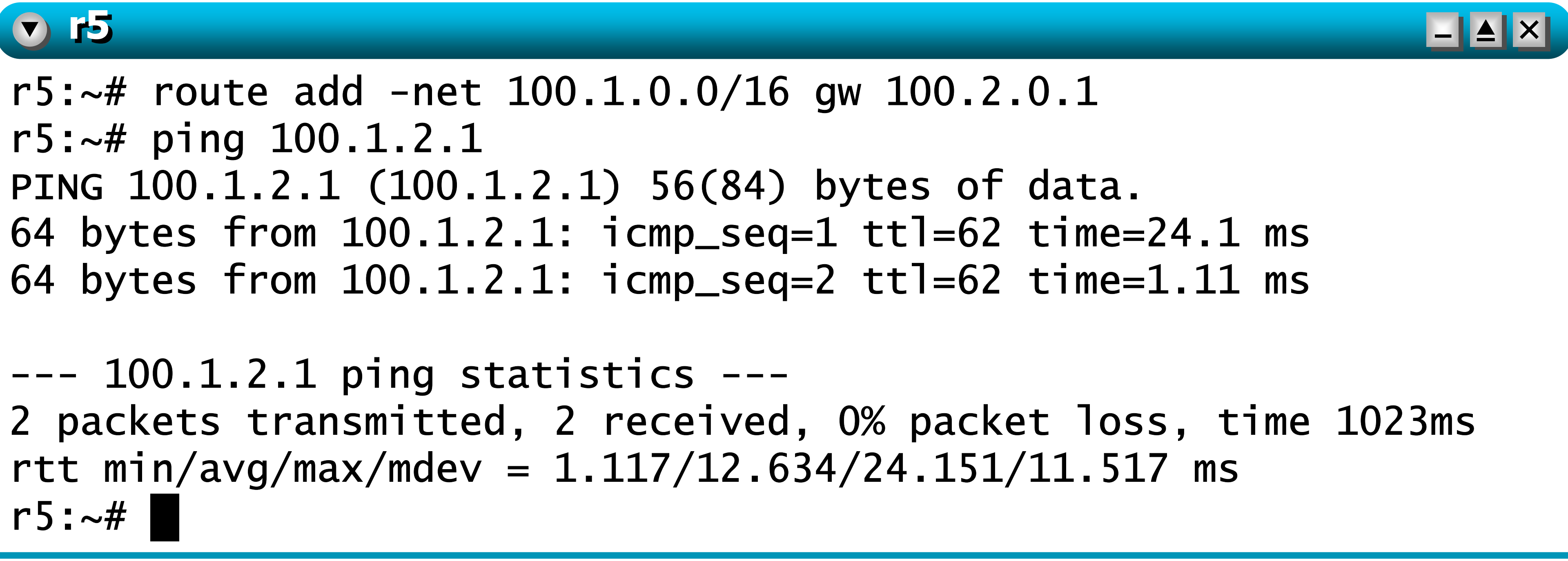
```
root@r4:/# vtysh
r4-frr# show ip rip
Codes: R - RIP, C - connected, S - Static, O - OSPF, B - BGP
Sub-codes:
      (n) - normal, (s) - static, (d) - default, (r) - redistribute,
      (i) - interface

     Network            Next Hop         Metric From            Tag Time
R(n) 100.1.0.0/30       100.1.0.13            2 100.1.0.13        0 02:47
R(n) 100.1.0.4/30       100.1.0.17            2 100.1.0.17        0 02:37
R(n) 100.1.0.8/30       100.1.0.17            2 100.1.0.17        0 02:37
C(i) 100.1.0.12/30      0.0.0.0               1 self              0
C(i) 100.1.0.16/30      0.0.0.0               1 self              0
R(n) 100.1.1.0/24       100.1.0.13            2 100.1.0.13        0 02:47
R(n) 100.1.2.0/24       100.1.0.17            3 100.1.0.17        0 02:37
R(n) 100.1.3.0/24       100.1.0.17            2 100.1.0.17        0 02:37
C(r) 100.1.4.0/24       0.0.0.0               1 self              0
C(r) 100.2.0.0/30       0.0.0.0               1 self              0
r4-frr#
```

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

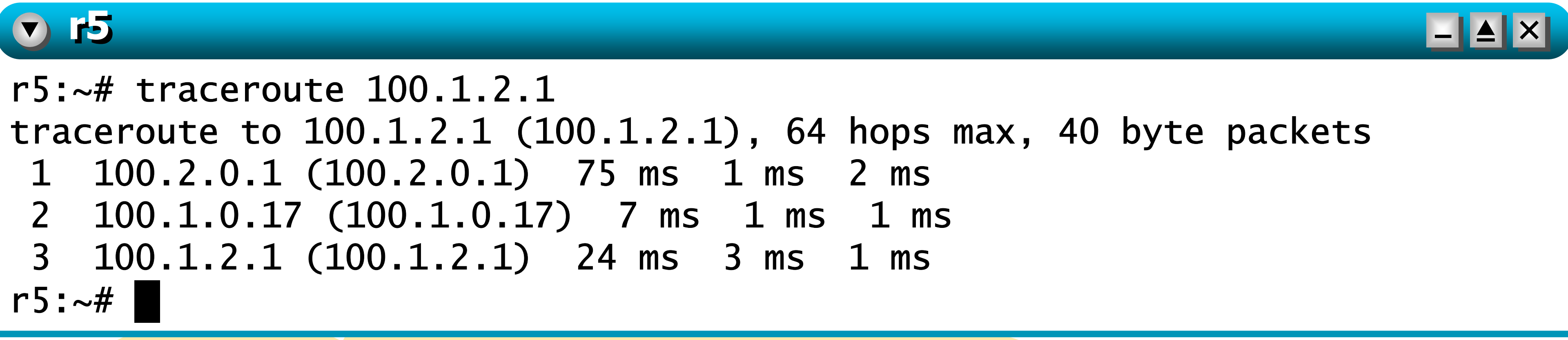


adding a static route to r5

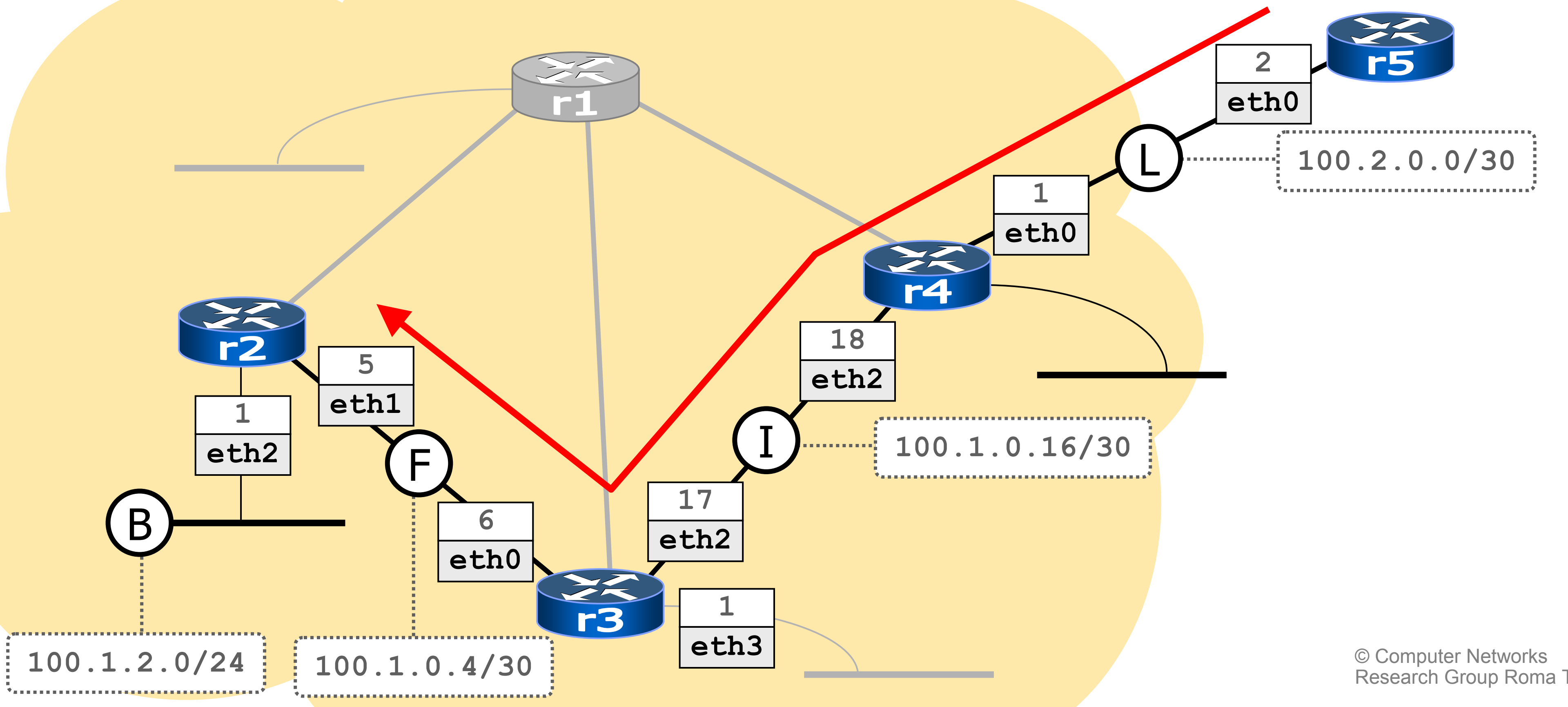


```
r5:~# route add -net 100.1.0.0/16 gw 100.2.0.1
r5:~# ping 100.1.2.1
PING 100.1.2.1 (100.1.2.1) 56(84) bytes of data.
64 bytes from 100.1.2.1: icmp_seq=1 ttl=62 time=24.1 ms
64 bytes from 100.1.2.1: icmp_seq=2 ttl=62 time=1.11 ms

--- 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

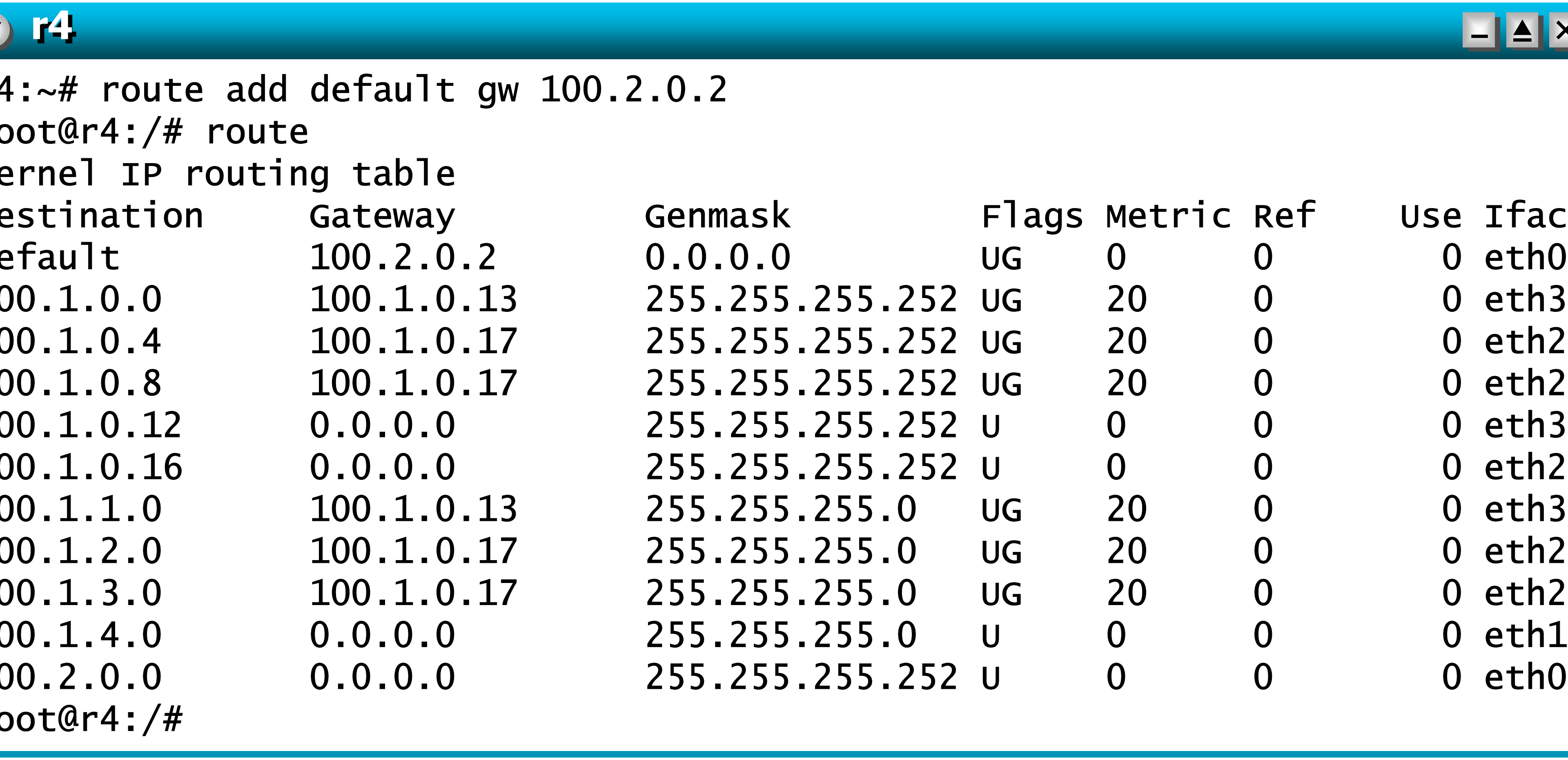


```
r5:~# traceroute 100.1.2.1
traceroute to 100.1.2.1 (100.1.2.1), 64 hops max, 40 byte packets
 1  100.2.0.1 (100.2.0.1)  75 ms  1 ms  2 ms
 2  100.1.0.17 (100.1.0.17)  7 ms  1 ms  1 ms
 3  100.1.2.1 (100.1.2.1)  24 ms  3 ms  1 ms
r5:~# █
```



configuring **r4**

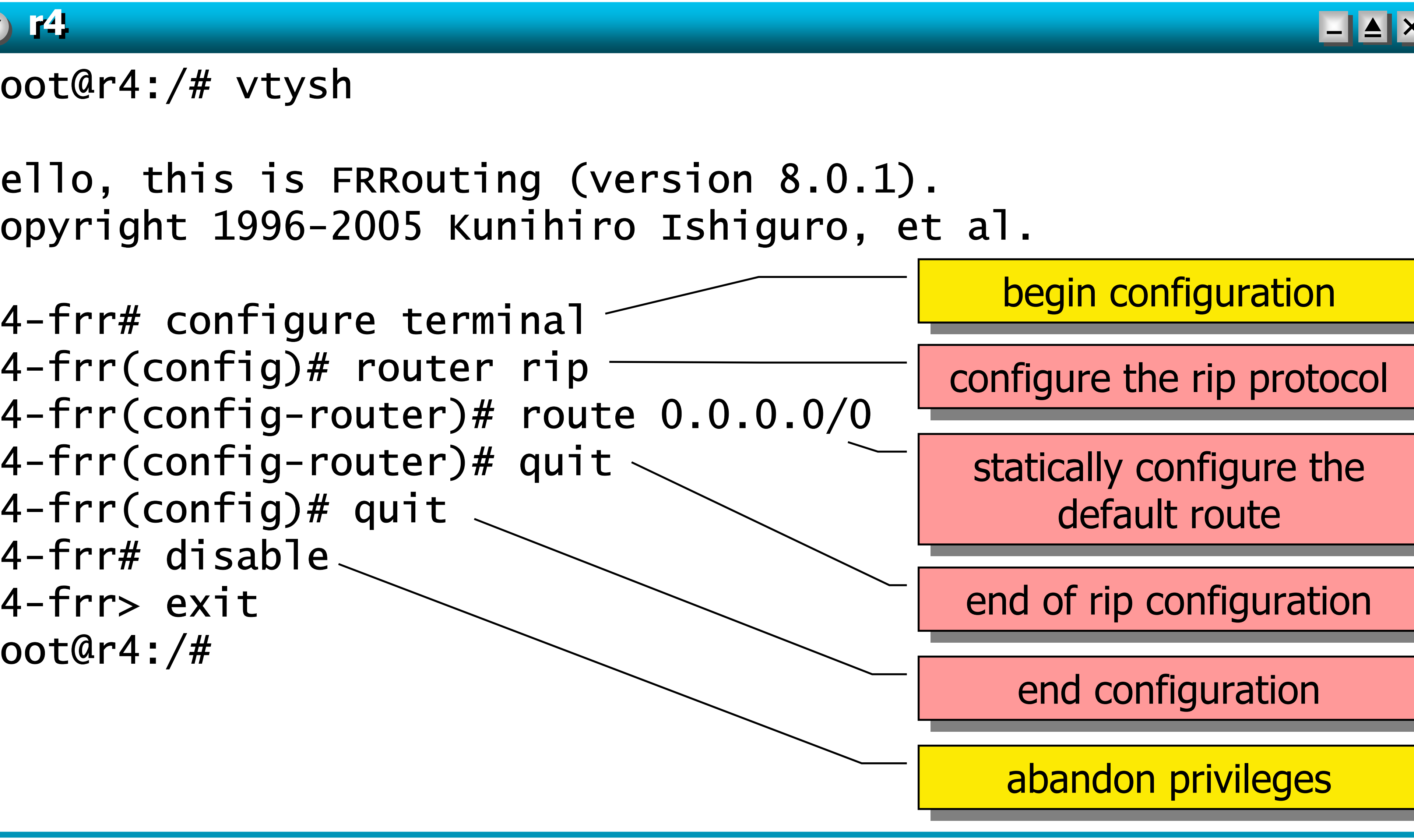
- step 1: configuring the default route



```
4:~# route add default gw 100.2.0.2
oot@r4:/# route
ernel IP routing table
estination     Gateway         Genmask         Flags Metric Ref    Use Ifac
efault         100.2.0.2       0.0.0.0         UG    0      0        0 eth0
00.1.0.0       100.1.0.13      255.255.255.252 UG    20     0        0 eth3
00.1.0.4       100.1.0.17      255.255.255.252 UG    20     0        0 eth2
00.1.0.8       100.1.0.17      255.255.255.252 UG    20     0        0 eth2
00.1.0.12      0.0.0.0         255.255.255.252 U     0      0        0 eth3
00.1.0.16      0.0.0.0         255.255.255.252 U     0      0        0 eth2
00.1.1.0       100.1.0.13      255.255.255.0   UG    20     0        0 eth3
00.1.2.0       100.1.0.17      255.255.255.0   UG    20     0        0 eth2
00.1.3.0       100.1.0.17      255.255.255.0   UG    20     0        0 eth2
00.1.4.0       0.0.0.0         255.255.255.0   U     0      0        0 eth1
00.2.0.0       0.0.0.0         255.255.255.252 U     0      0        0 eth0
oot@r4:/#
```

configuring r4

- step 2: propagating the default route into rip



```
oot@r4:/# vtysh

ello, this is FRRouting (version 8.0.1).
opyright 1996-2005 Kunihiro Ishiguro, et al.

4-frr# configure terminal
4-frr(config)# router rip
4-frr(config-router)# route 0.0.0.0/0
4-frr(config-router)# quit
4-frr(config)# quit
4-frr# disable
4-frr> exit
oot@r4:/#
```

begin configuration

configure the rip protocol

statically configure the default route

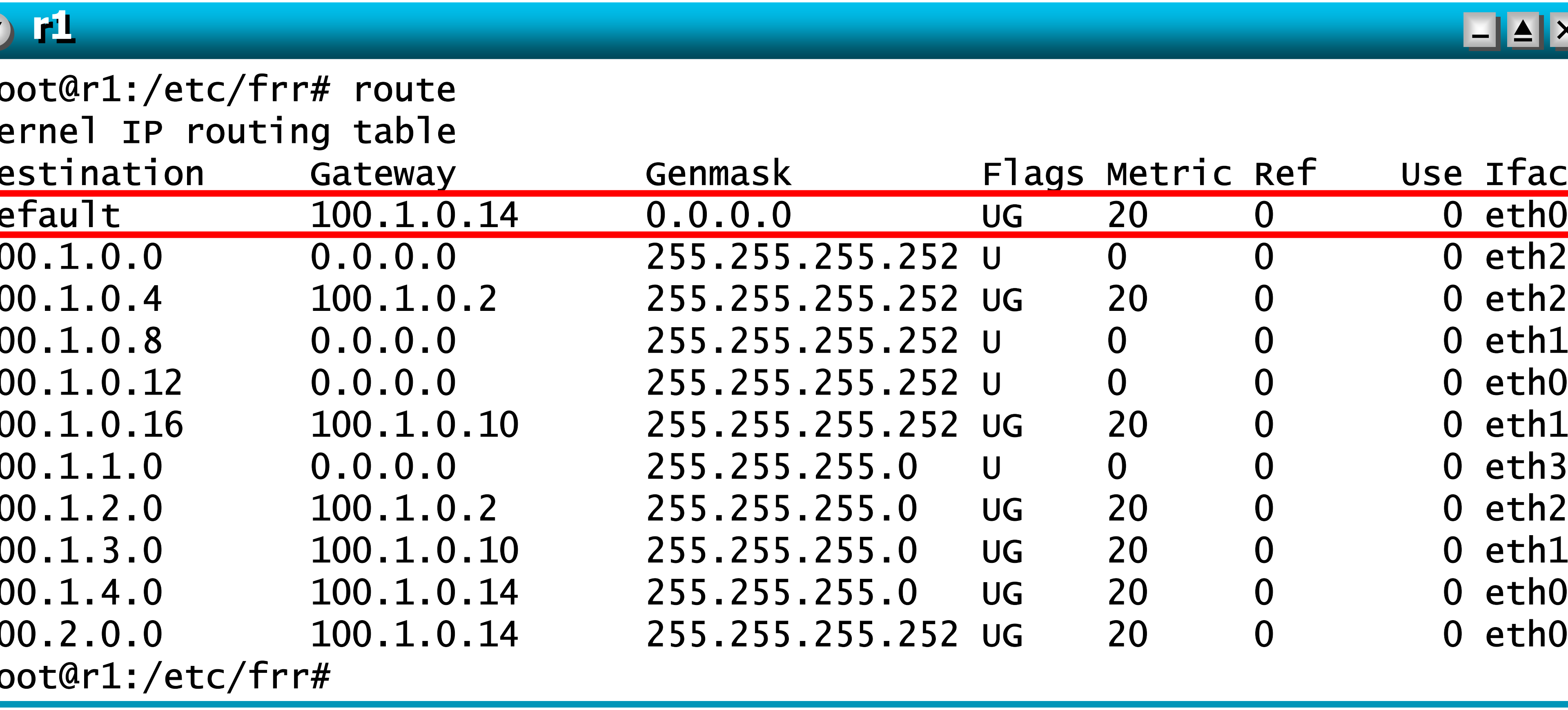
end of rip configuration

end configuration

abandon privileges

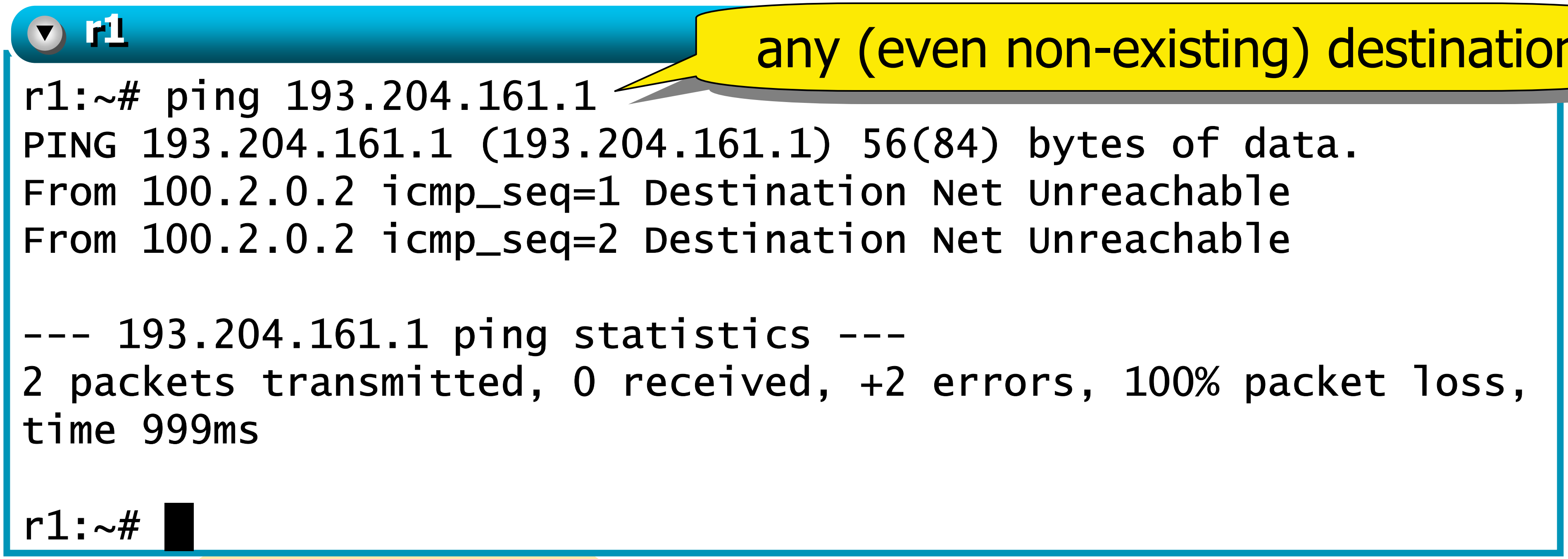
the default route

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



```
oot@r1:/etc/frr# route
ernel IP routing table
estination      Gateway         Genmask         Flags Metric Ref    Use Ifac
efault          100.1.0.14      0.0.0.0         UG    20     0        0 eth0
00.1.0.0        0.0.0.0         255.255.255.252 U     0      0        0 eth2
00.1.0.4        100.1.0.2       255.255.255.252 UG    20     0        0 eth2
00.1.0.8        0.0.0.0         255.255.255.252 U     0      0        0 eth1
00.1.0.12       0.0.0.0         255.255.255.252 U     0      0        0 eth0
00.1.0.16       100.1.0.10      255.255.255.252 UG    20     0        0 eth1
00.1.1.0        0.0.0.0         255.255.255.0   U     0      0        0 eth3
00.1.2.0        100.1.0.2       255.255.255.0   UG    20     0        0 eth2
00.1.3.0        100.1.0.10      255.255.255.0   UG    20     0        0 eth1
00.1.4.0        100.1.0.14      255.255.255.0   UG    20     0        0 eth0
00.2.0.0        100.1.0.14      255.255.255.252 UG    20     0        0 eth0
oot@r1:/etc/frr#
```

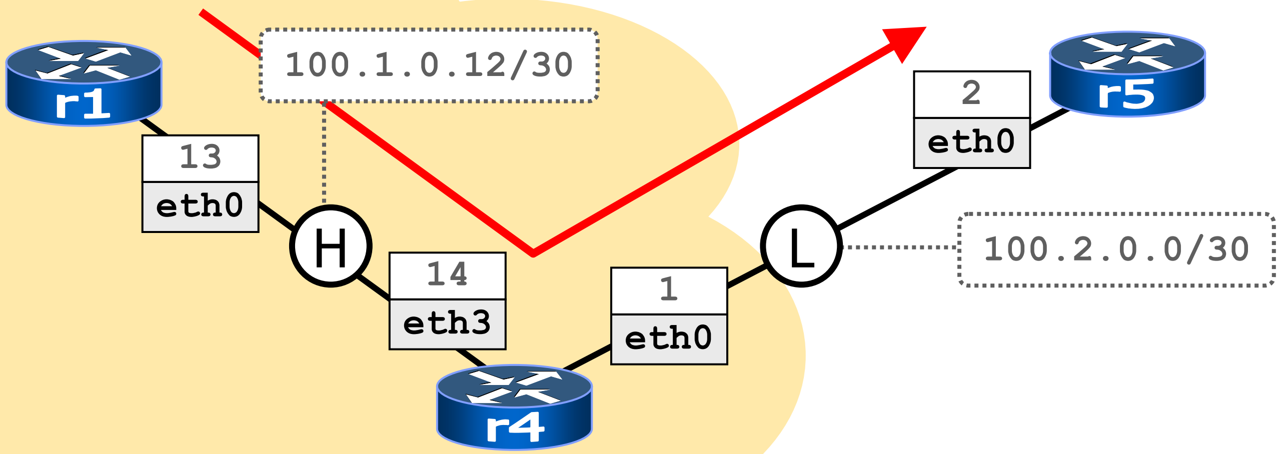
checking connectivity



r1

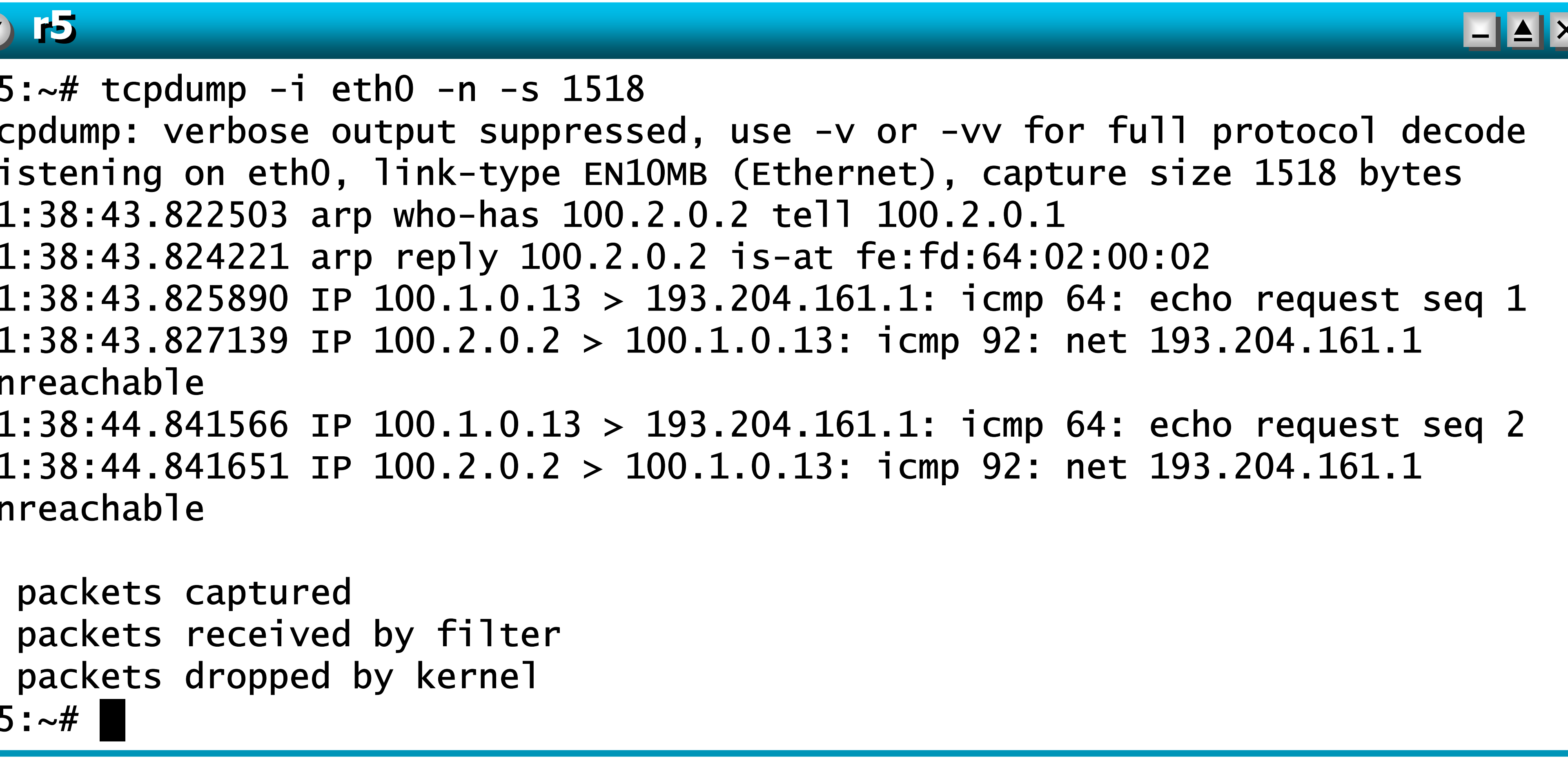
```
r1:~# ping 193.204.161.1
PING 193.204.161.1 (193.204.161.1) 56(84) bytes of data.
From 100.2.0.2 icmp_seq=1 Destination Net Unreachable
From 100.2.0.2 icmp_seq=2 Destination Net Unreachable

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

r1:~# █
```

any (even non-existing) destination



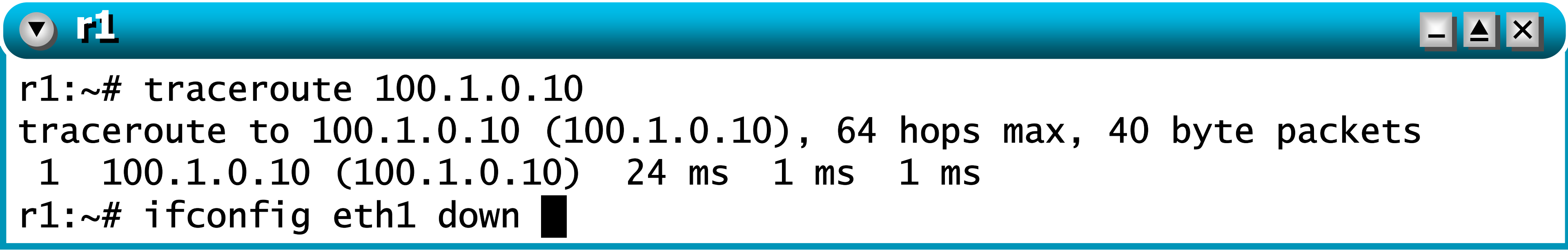
checking connectivity

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

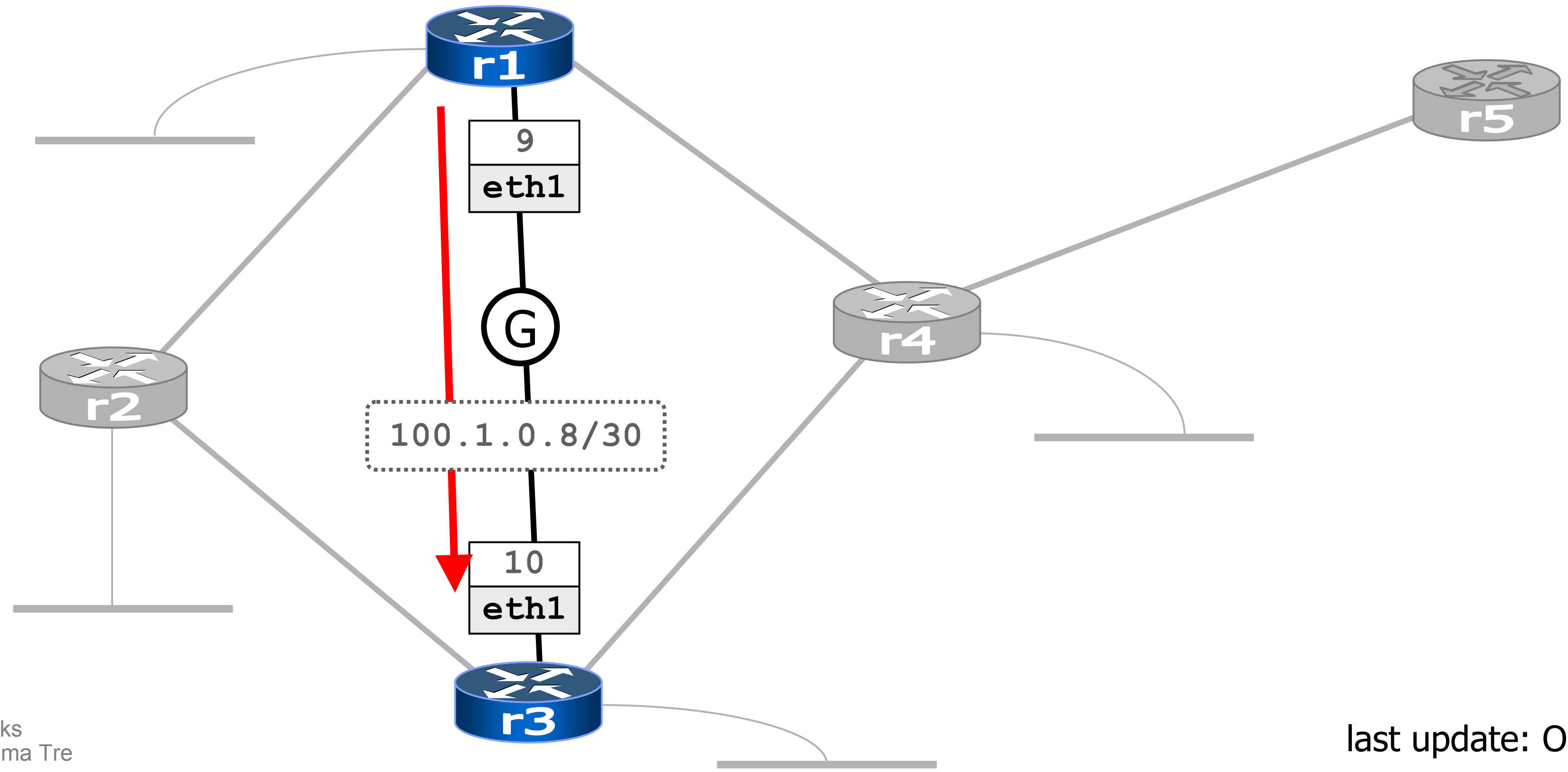


```
5:~# tcpdump -i eth0 -n -s 1518
cpdump: verbose output suppressed, use -v or -vv for full protocol decode
istening on eth0, link-type EN10MB (Ethernet), capture size 1518 bytes
1:38:43.822503 arp who-has 100.2.0.2 tell 100.2.0.1
1:38:43.824221 arp reply 100.2.0.2 is-at fe:fd:64:02:00:02
1:38:43.825890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

 packets captured
 packets received by filter
 packets dropped by kernel
5:~# █
```

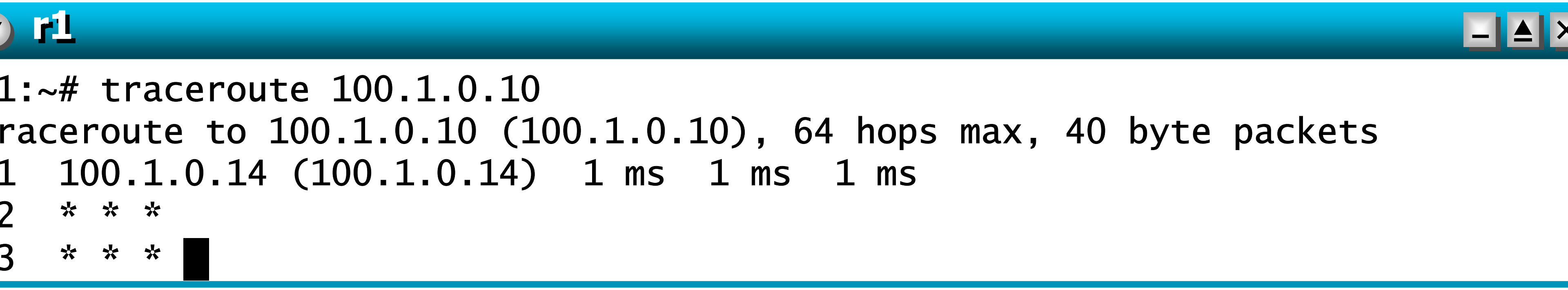
shutting down an interface



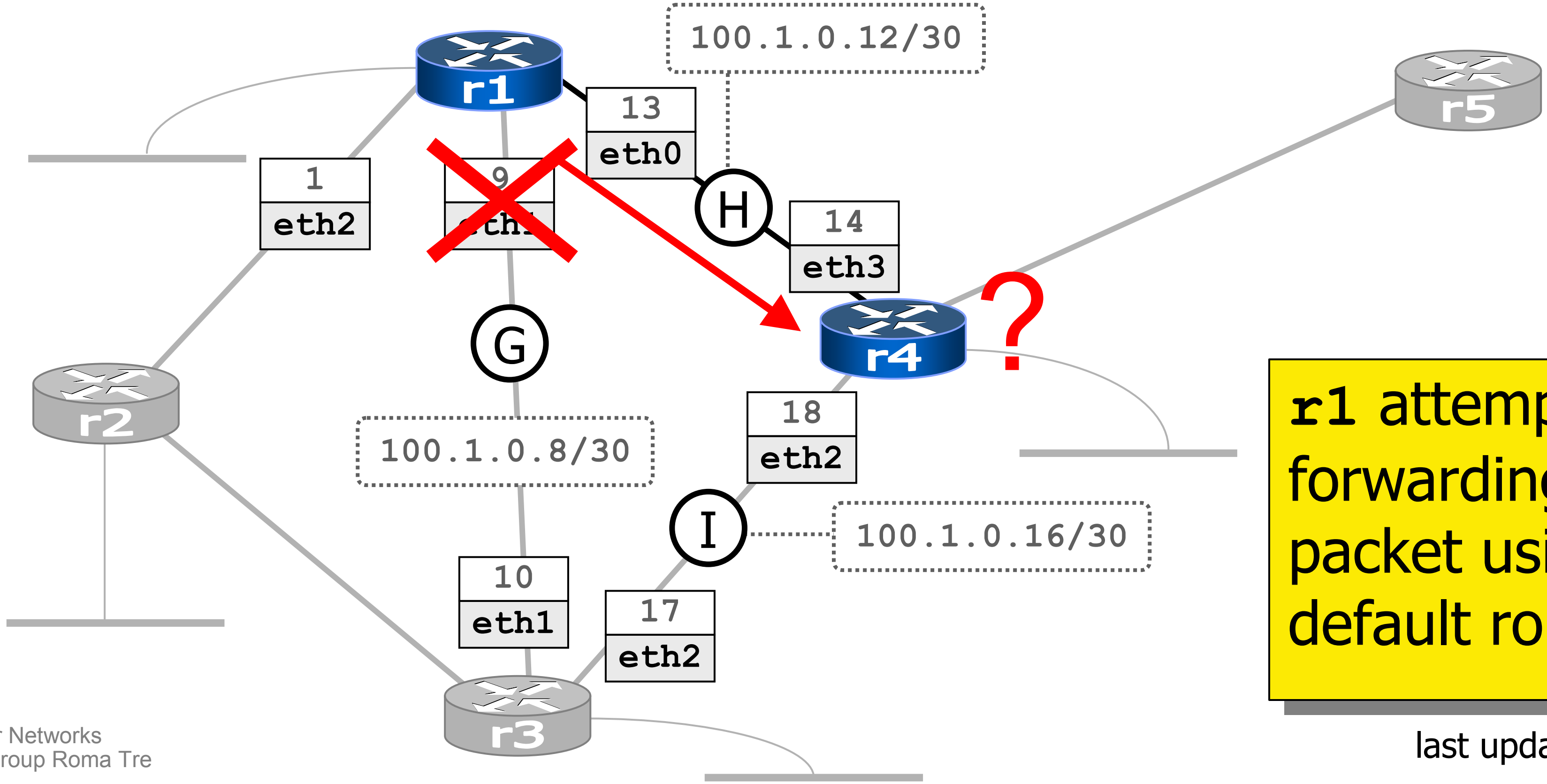
```
r1:~# traceroute 100.1.0.10
traceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
 1  100.1.0.10 (100.1.0.10)  24 ms  1 ms  1 ms
r1:~# ifconfig eth1 down
```



shutting down an interface

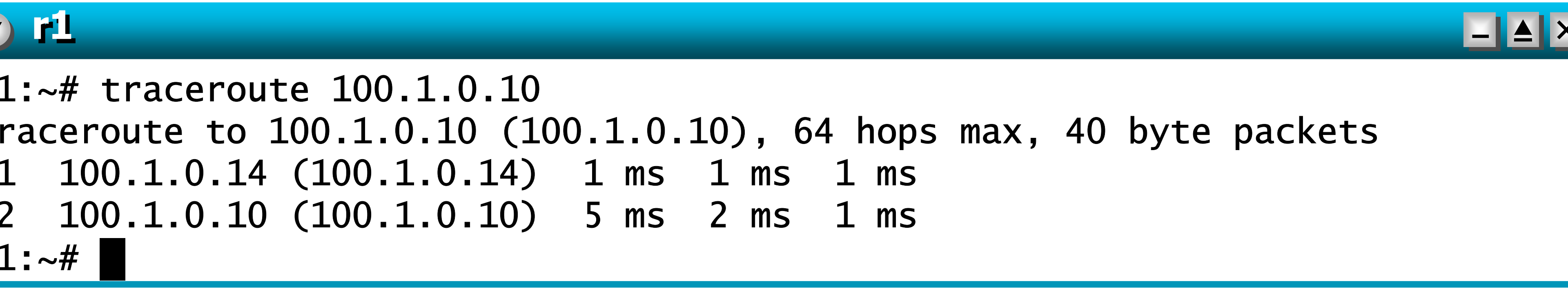


```
1:~# traceroute 100.1.0.10
raceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
1  100.1.0.14 (100.1.0.14)  1 ms  1 ms  1 ms
2  * * *
3  * * *
```

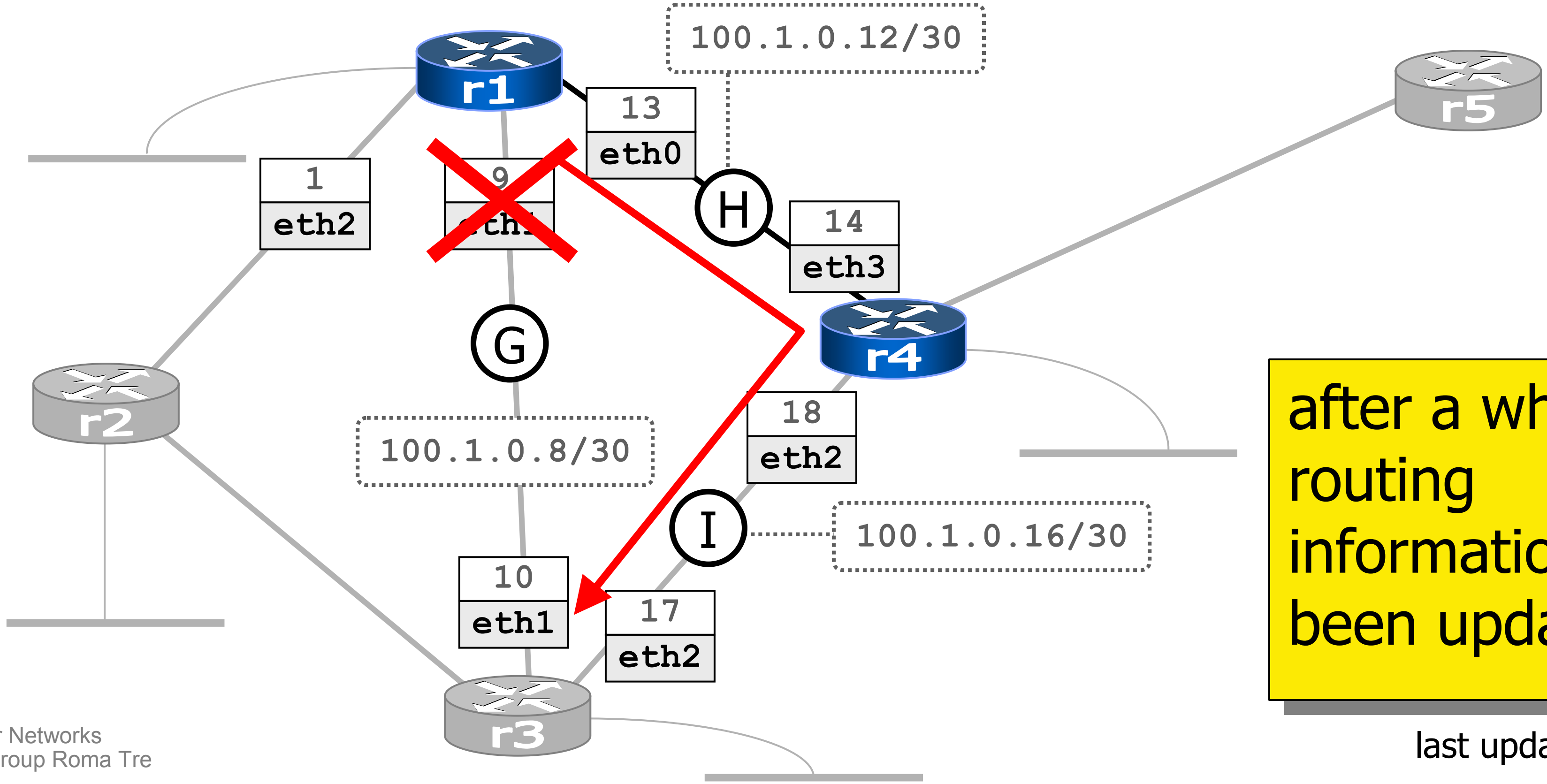


r1 attempts forwarding the packet using the default route

shutting down an interface



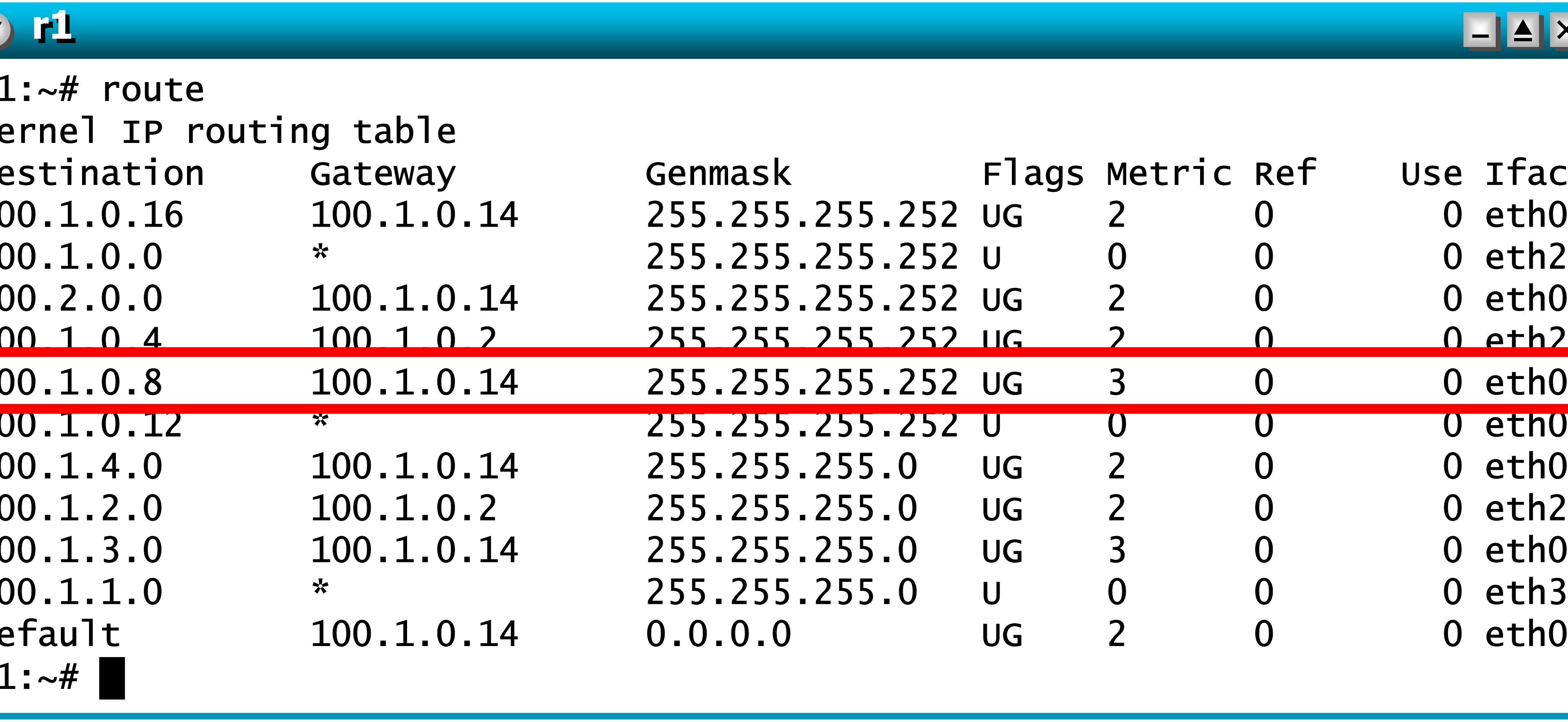
```
1:~# traceroute 100.1.0.10
raceroute to 100.1.0.10 (100.1.0.10), 64 hops max, 40 byte packets
1  100.1.0.14 (100.1.0.14)  1 ms  1 ms  1 ms
2  100.1.0.10 (100.1.0.10)  5 ms  2 ms  1 ms
1:~# 
```



after a while, routing information has been updated

shutting down an interface

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



```
1:~# route
ernel IP routing table
estination     Gateway         Genmask         Flags Metric Ref    Use Ifac
00.1.0.16      100.1.0.14      255.255.255.252 UG    2      0        0 eth0
00.1.0.0       *               255.255.255.252 U     0      0        0 eth2
00.2.0.0       100.1.0.14      255.255.255.252 UG    2      0        0 eth0
00.1.0.4       100.1.0.2       255.255.255.252 UG    2      0        0 eth2
00.1.0.8       100.1.0.14      255.255.255.252 UG    3      0        0 eth0
00.1.0.12      *               255.255.255.252 U     0      0        0 eth0
00.1.4.0       100.1.0.14      255.255.255.0   UG    2      0        0 eth0
00.1.2.0       100.1.0.2       255.255.255.0   UG    2      0        0 eth2
00.1.3.0       100.1.0.14      255.255.255.0   UG    3      0        0 eth0
00.1.1.0       *               255.255.255.0   U     0      0        0 eth3
efault         100.1.0.14      0.0.0.0         UG    2      0        0 eth0
1:~# █
```