Static routing – ruting statyczny

- W ramach zajęć należy stworzyć prostą sieć składającą się z czterech maszyn wirtualnych – dwóch komputerów (PC1 I PC2) oraz dwóch ruterów (R1 i R2).
  - Adresy IP poszczególnych interfejsów urządzeń zostały już skonfigurowane, należy sprawdzić poprawność tej konfiguracji
  - Należy zbadać łączność pomiędzy urządzeniami końcowymi z użyciem polecenia **`ping`** i sprawdzić zawartość tablic rutingu z użyciem polecenia **`route`**
  - Należy uzupełnić konfigurację urządzeń w taki sposób, aby ruting statyczny działał poprawnie
  - Należy użyć programu **`tcpdump`** w celach diagnostycznych
- Działania te powinny umożliwić komunikację komputerów za pośrednictwem sieci

Static routing – ruting statyczny

- **Głównym celem zajęć jest**
  - skonfigurowanie rutingu statycznego
  - analiza działania rutingu statycznego
  - lepsze zapoznanie się ze środowiskiem **`netkit`**

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netkit lab

static-routing

Version	2.2
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Web	http://www.netkit.org/
Description	an example of configuration of static routes

Modified for the purpose of the IP Networks LAB

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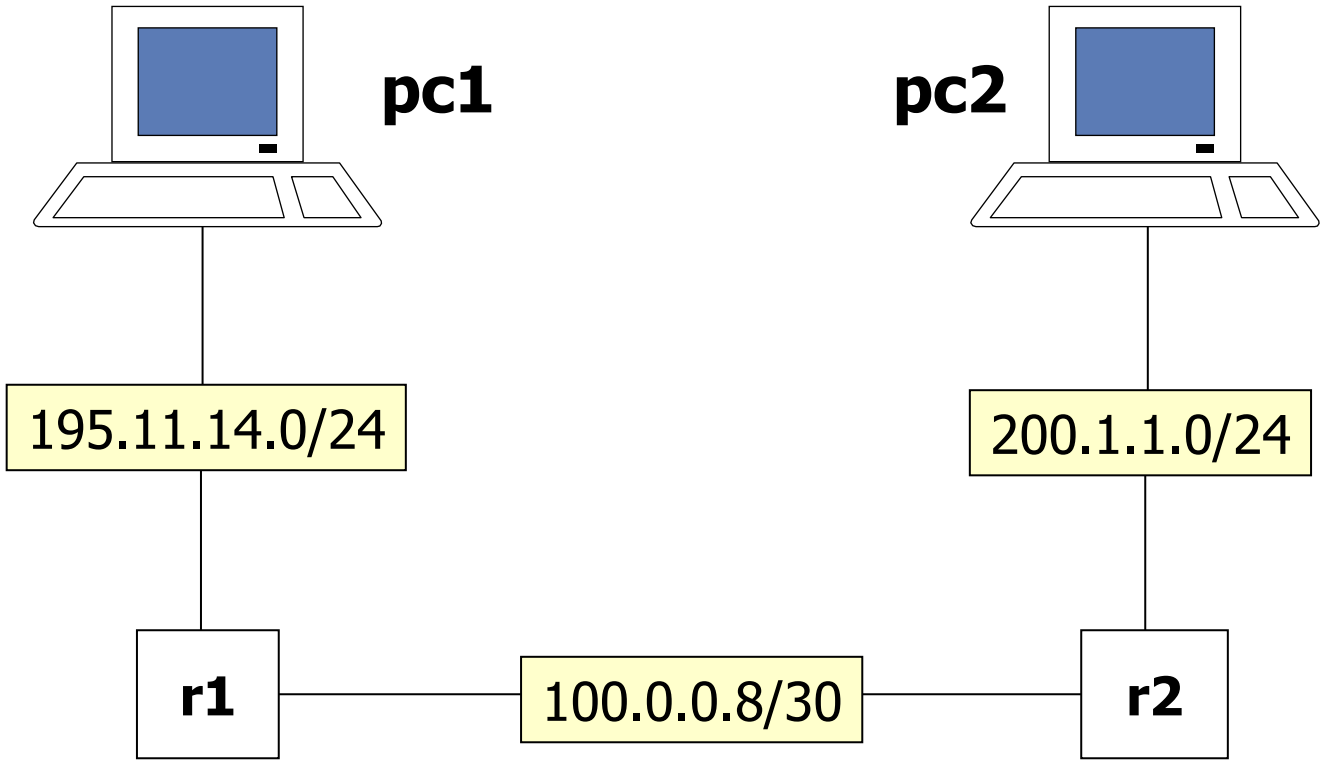
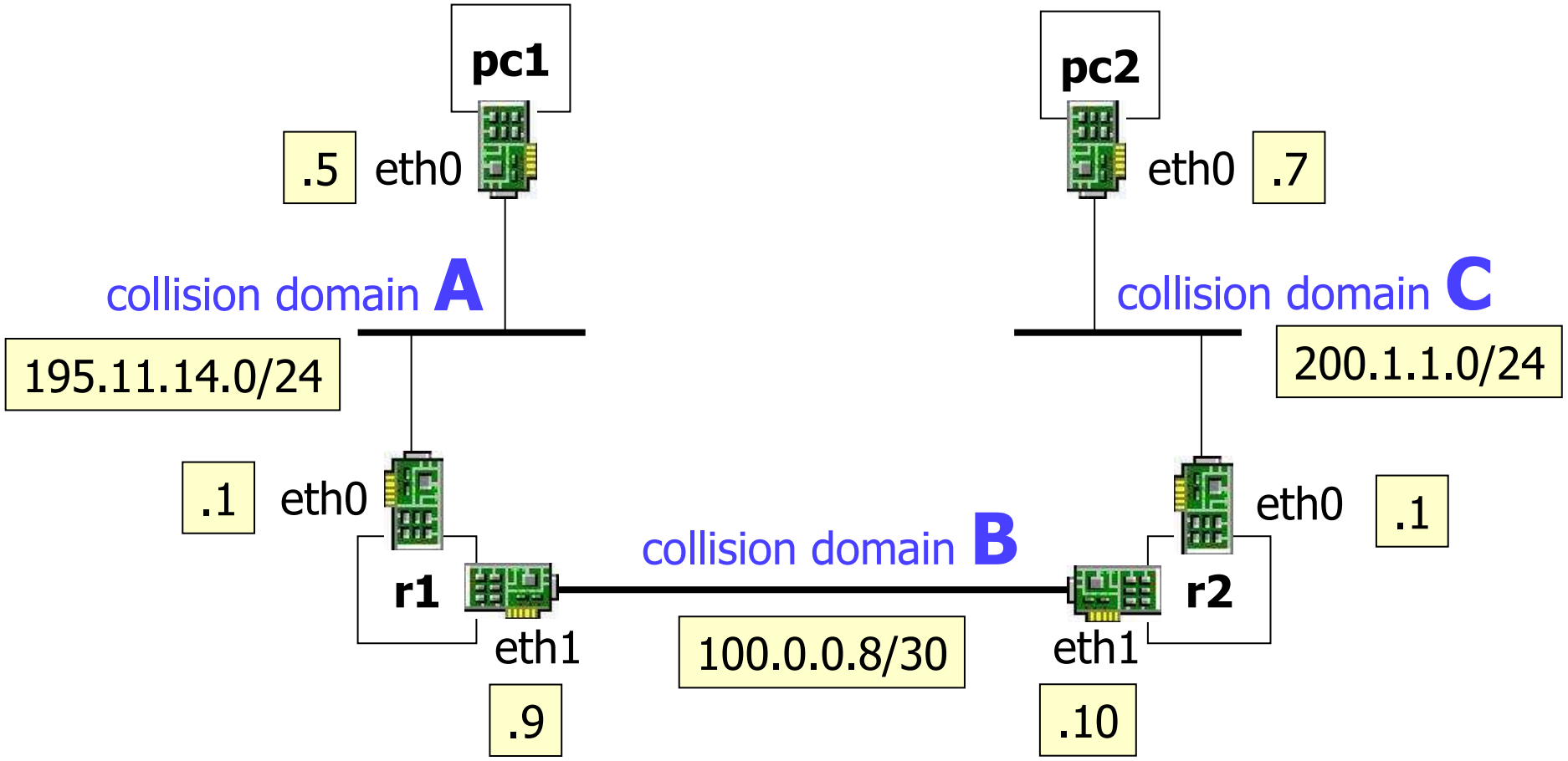
step 1 – network topology high level view



step 1 – network topology configuration details



Lab Scenario Personalization

- Please modify the default scenario in the following way
  - In the next slide change the name of `r1` to `r<LAB-ID>` for each configuration file, 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 naming, therefore there can be differences in the outputs shown in the manual

step 2 – the lab

- lab directory hierarchy
  - lab.conf
  - pc1/
  - pc1.startup
  - pc2/
  - pc2.startup
  - r1/
  - r1.startup
  - r2/
  - r2.startup

step 2 – the lab

lab.conf

```
r1[0]="A"
r1[1]="B"

r2[0]="C"
r2[1]="B"

pc1[0]="A"
pc2[0]="C"
```

pc1.startup

```
ifconfig eth0 195.11.14.5 netmask 255.255.255.0 broadcast 195.11.14.255 up
#route add default gw 195.11.14.1 dev eth0
```

the routing table entries will be added manually

pc2.startup

```
ifconfig eth0 200.1.1.7 netmask 255.255.255.0 broadcast 200.1.1.255 up
#route add default gw 200.1.1.1 dev eth0
```

step 2 – the lab

r1.startup

```
ifconfig eth0 195.11.14.1 netmask 255.255.255.0 broadcast 195.11.14.255 up
ifconfig eth1 100.0.0.9 netmask 255.255.255.252 broadcast 100.0.0.11 up
#route add -net 200.1.1.0 netmask 255.255.255.0 gw 100.0.0.10 dev eth1
```

r2.startup

```
ifconfig eth0 200.1.1.1 netmask 255.255.255.0 broadcast 200.1.1.255 up
ifconfig eth1 100.0.0.10 netmask 255.255.255.252 broadcast 100.0.0.11 up
#route add -net 195.11.14.0 netmask 255.255.255.0 gw 100.0.0.9 dev eth1
```

the routing table entries will be added manually

Now start the lab using the lstart command in the lab directory

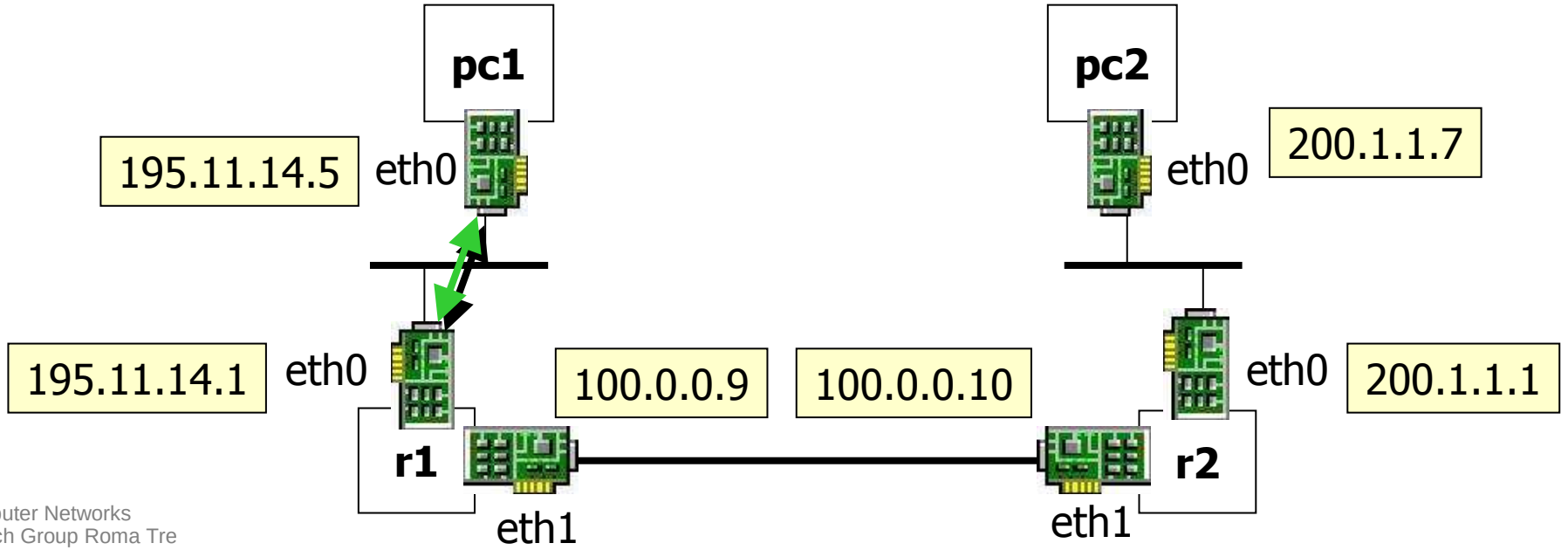
step 3 – testing connectivity

pc1

```
pc1:~# ping 195.11.14.1
PING 195.11.14.1 (195.11.14.1) 56(84) bytes of data.
64 bytes from 195.11.14.1: icmp_seq=1 ttl=64 time=3.17 ms
64 bytes from 195.11.14.1: icmp_seq=2 ttl=64 time=0.371 ms
64 bytes from 195.11.14.1: icmp_seq=3 ttl=64 time=0.308 ms

--- 195.11.14.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2019ms
rtt min/avg/max/mdev = 0.308/1.285/3.176/1.337 ms
pc1:~#
```

interfaces on the same domain can reach each other



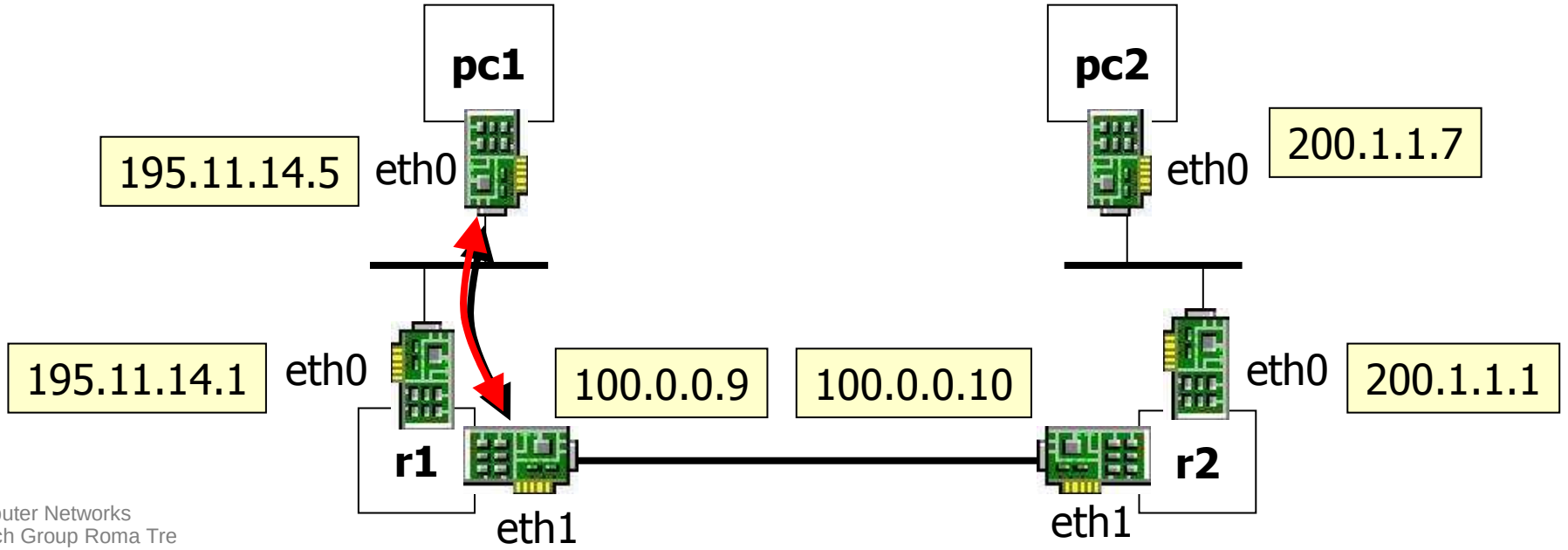
step 3 – testing connectivity

pc1

```
pc1:~# ping 100.0.0.9
connect: Network is unreachable
pc1:~#
```

interfaces on different domains cannot be reached

can you tell why?



step 3 – inspecting routing tables

- both routers and pcs don't know how to reach networks that are not directly connected to them

pc1

```
pc1:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
195.11.14.0     *               255.255.255.0   U     0      0        0 eth0
pc1:~#
```

r1

```
r1:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
100.0.0.8       *               255.255.255.252 U     0      0        0 eth1
195.11.14.0     *               255.255.255.0   U     0      0        0 eth0
r1:~#
```

- directly connected networks are automatically inserted into the routing table when the corresponding interface is brought up
- this is a common behavior of all ip devices (even real-world routers!)

step 4 – default routes on pcs

- to fix the problem we could specify the default route on the pcs: "through this gateway (ip number) you can reach all the other networks"

pc1

```
pc1:~# route add default gw 195.11.14.1
pc1:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
195.11.14.0     *               255.255.255.0   U     0      0        0 eth0
default         195.11.14.1     0.0.0.0         UG    0      0        0 eth0
pc1:~#
```

pc2

```
pc2:~# route add default gw 200.1.1.1
pc2:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
200.1.1.0       *               255.255.255.0   U     0      0        0 eth0
default         200.1.1.1       0.0.0.0         UG    0      0        0 eth0
pc2:~#
```

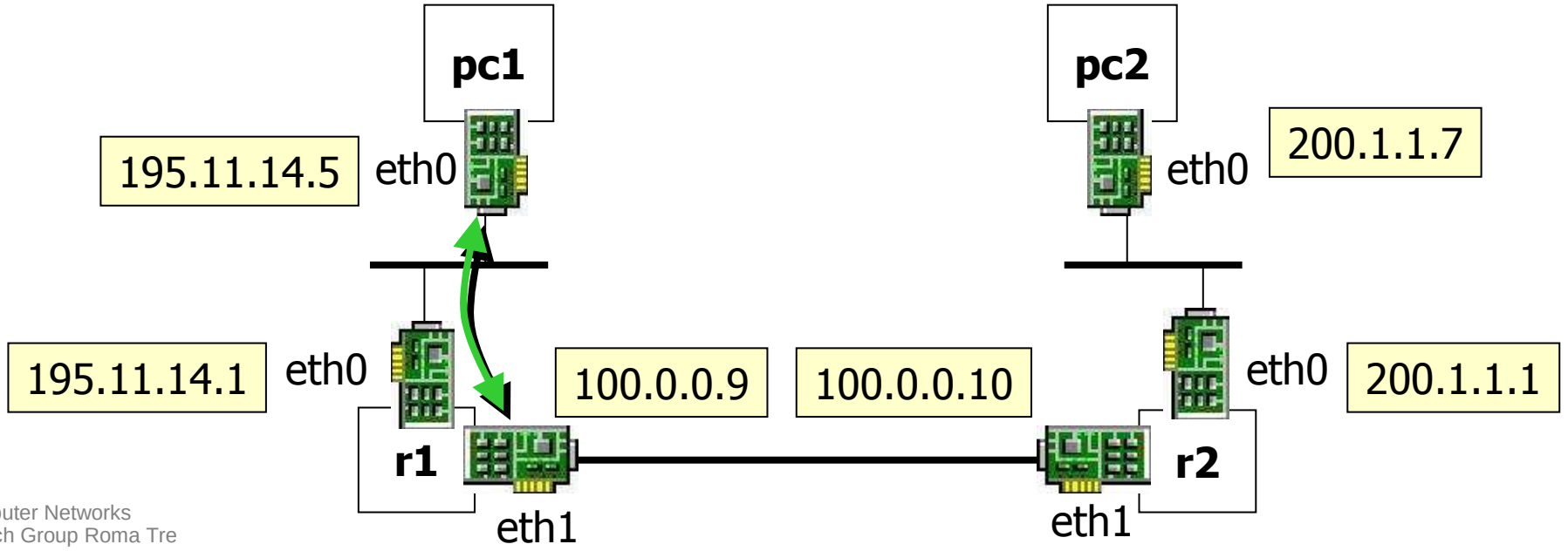
step 4 – default routes on pcs: test

pc1

```
pc1:~# ping 100.0.0.9
PING 100.0.0.9 (100.0.0.9) 56(84) bytes of data.
64 bytes from 100.0.0.9: icmp_seq=1 ttl=64 time=0.451 ms
64 bytes from 100.0.0.9: icmp_seq=2 ttl=64 time=0.299 ms
64 bytes from 100.0.0.9: icmp_seq=3 ttl=64 time=0.320 ms

--- 100.0.0.9 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/mdev = 0.299/0.356/0.451/0.070 ms
pc1:~#
```

the "backbone interface" of **r1** is reachable



step 4 – default routes on pcs: test

pc1

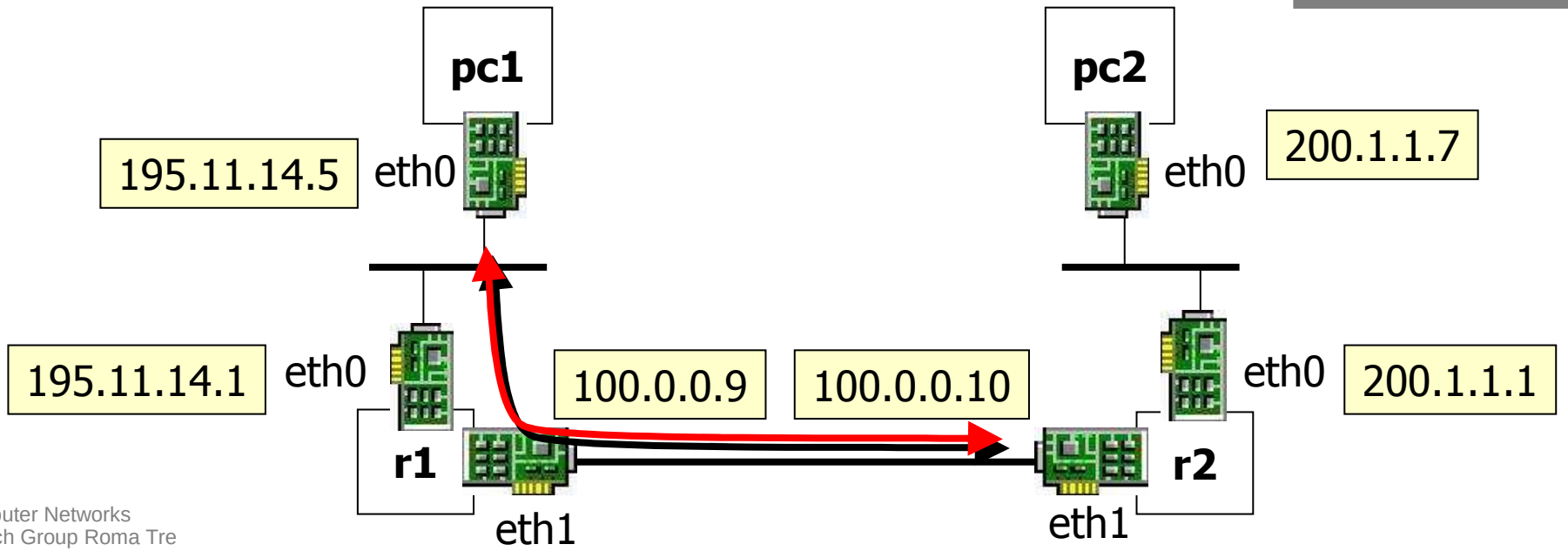
```
pc1:~# ping 100.0.0.10
PING 100.0.0.10 (100.0.0.10) 56(84) bytes of data.

--- 100.0.0.10 ping statistics ---
7 packets transmitted, 0 received, 100% packet loss, time 6105ms

pc1:~# 
```

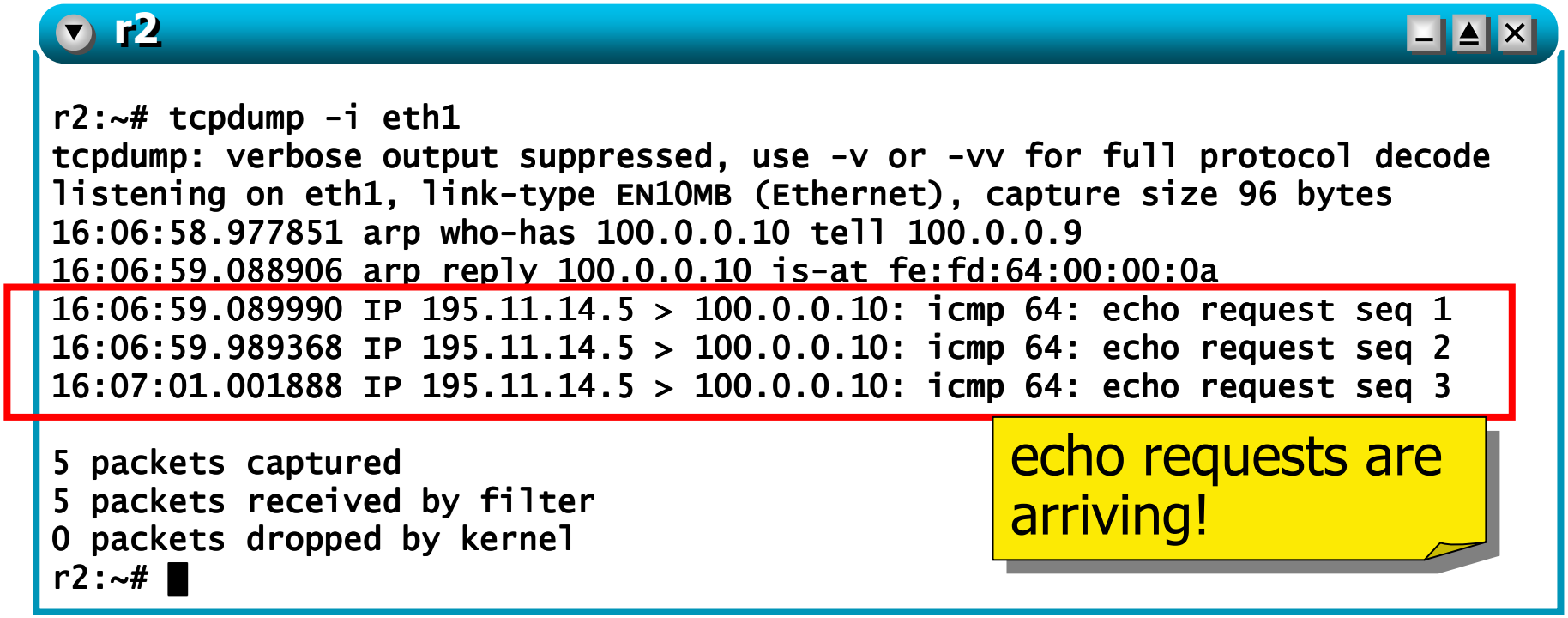
interfaces on **r2** seem unreachable!

can you tell why?

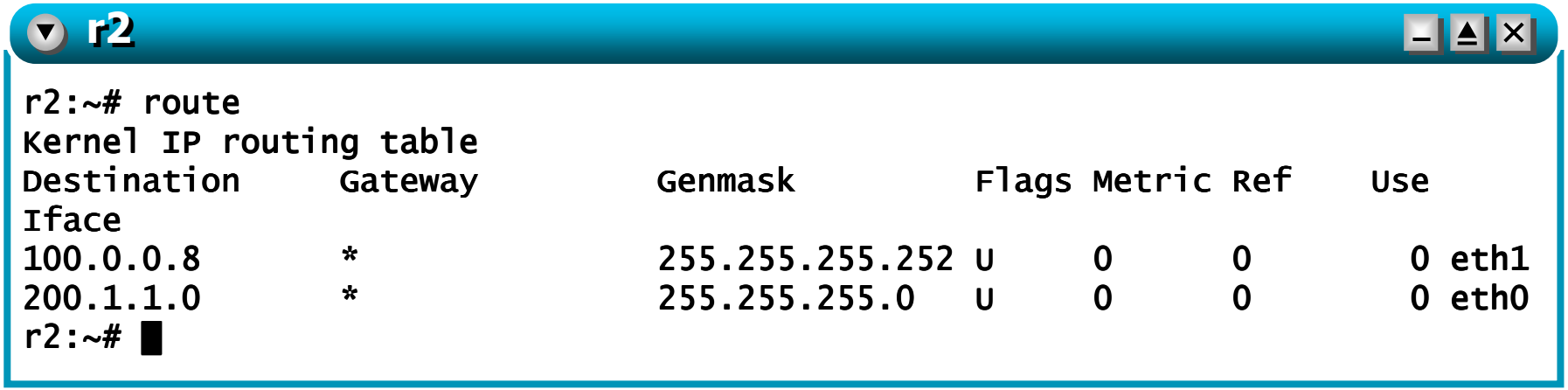


step 4 – let's inspect the network

- do echo request packets reach **r2**?
- let's check...
  - while pinging from **pc1** 100.0.0.10 sniff on interface **eth1** of **r2**

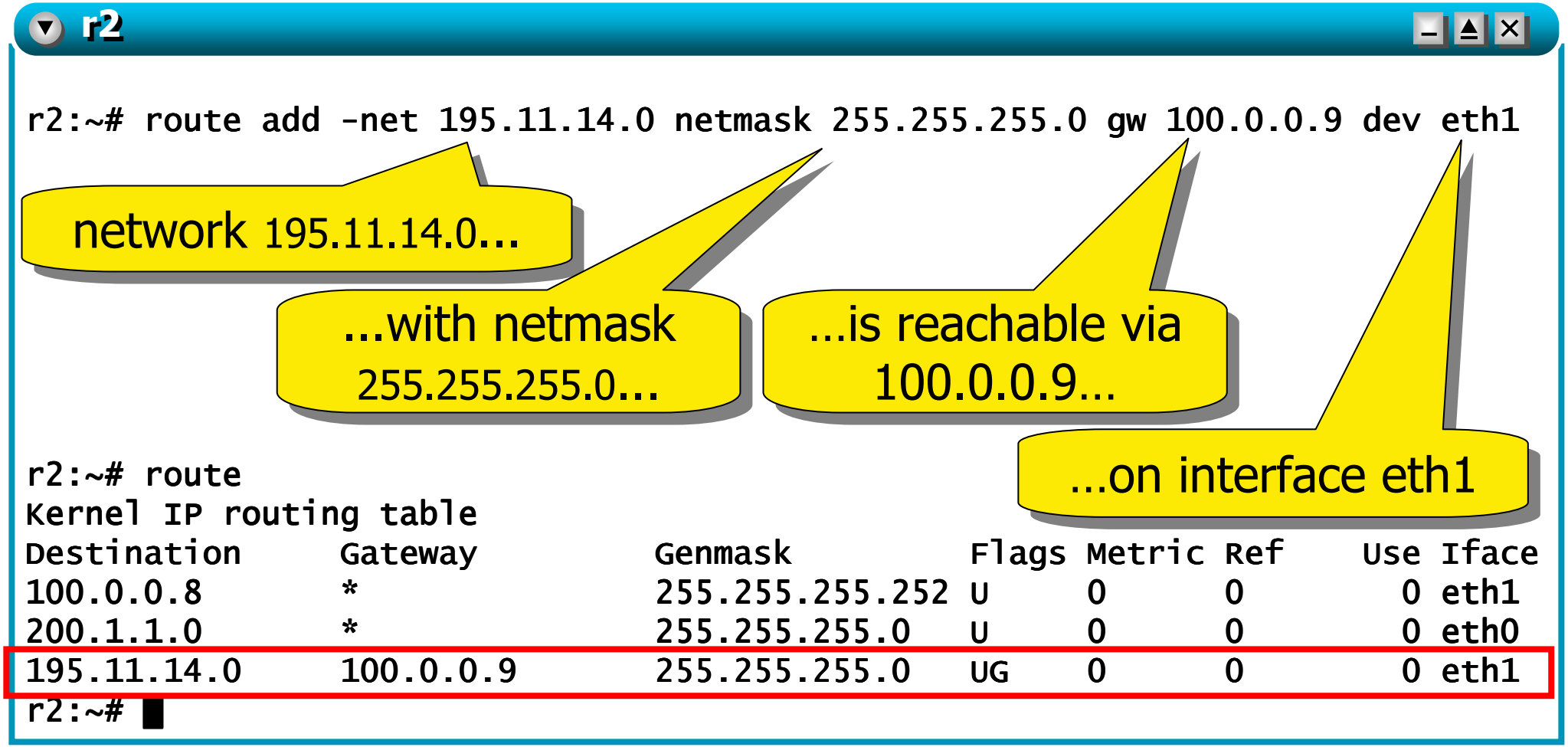


step 4 – **r2**'s routing table



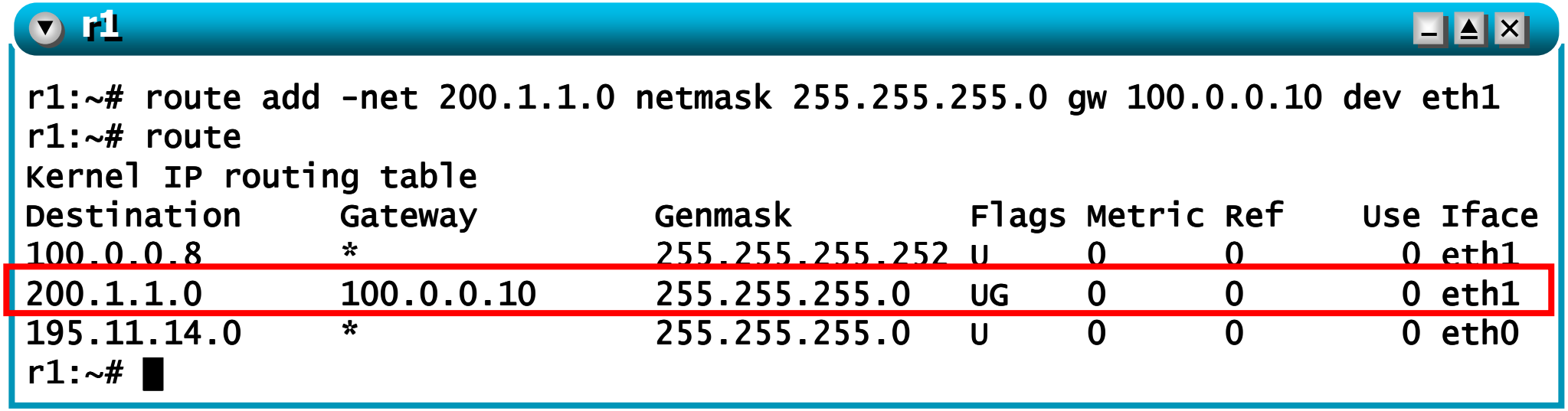
- **pc1**'s address is 195.11.14.5
- **r2** does not know how to reach such an address.
- echo requests arrive to **r2** but **r2** does not know where echo replies should be forwarded!
- somebody should teach **r2** how to reach **pc1**
- we may insert a static route into the routing table of **r2**

step 5 – configuring a static route



step 5 – configuring a static route

- a similar configuration should be deployed on **r1**



step 5 – testing static routes

- the pcs can reach each other

pc1

```
pc1:~# ping 200.1.1.7
PING 200.1.1.7 (200.1.1.7) 56(84) bytes of data.
64 bytes from 200.1.1.7: icmp_seq=1 ttl=62 time=111 ms
64 bytes from 200.1.1.7: icmp_seq=2 ttl=62 time=1.05 ms
64 bytes from 200.1.1.7: icmp_seq=3 ttl=62 time=0.820 ms

--- 200.1.1.7 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2042ms
rtt min/avg/max/mdev = 0.820/37.779/111.467/52.105 ms
pc1:~#
```

pc2

```
pc2:~# ping 195.11.14.5
PING 195.11.14.5 (195.11.14.5) 56(84) bytes of data.
64 bytes from 195.11.14.5: icmp_seq=1 ttl=62 time=0.954 ms
64 bytes from 195.11.14.5: icmp_seq=2 ttl=62 time=0.947 ms
64 bytes from 195.11.14.5: icmp_seq=3 ttl=62 time=1.27 ms

--- 195.11.14.5 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2049ms
rtt min/avg/max/mdev = 0.947/1.057/1.271/0.153 ms
pc2:~#
```

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 commands:
     - **`route`** executed on router r<LAB-ID>
     - **`ping 200.1.1.7`** executed on pc1
     - **`ping 195.11.14.5`** executed on pc2

obligatory exercises

- the default route can be statically configured by using

```
route add default gw 195.11.14.1 dev eth0
```

- can you give a command to configure a static route that is equivalent to the default route?

```
route add -net __ netmask __ gw __ dev __
```

obligatory exercises

- not all the routing tables contain a default route
- the network of this lab is so simple that routers **`r1`** and **`r2`** can be also configured to **exclusively** use default routes (i.e., static routes should be removed)
- try such a configuration and test it