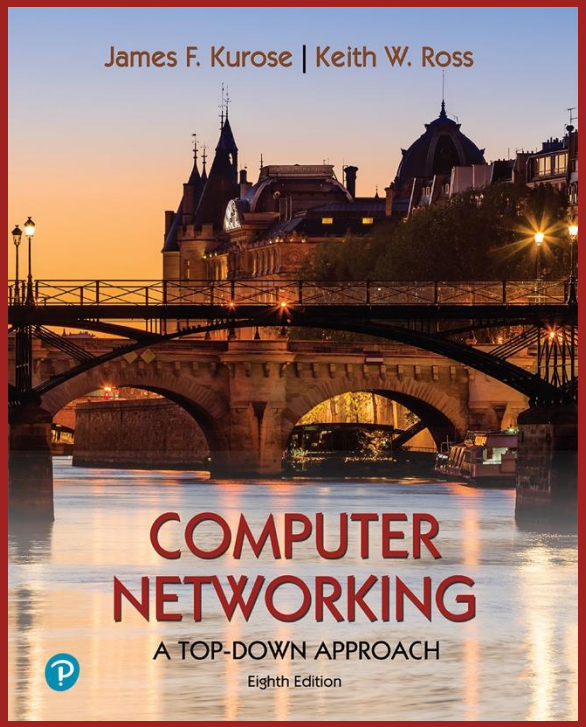
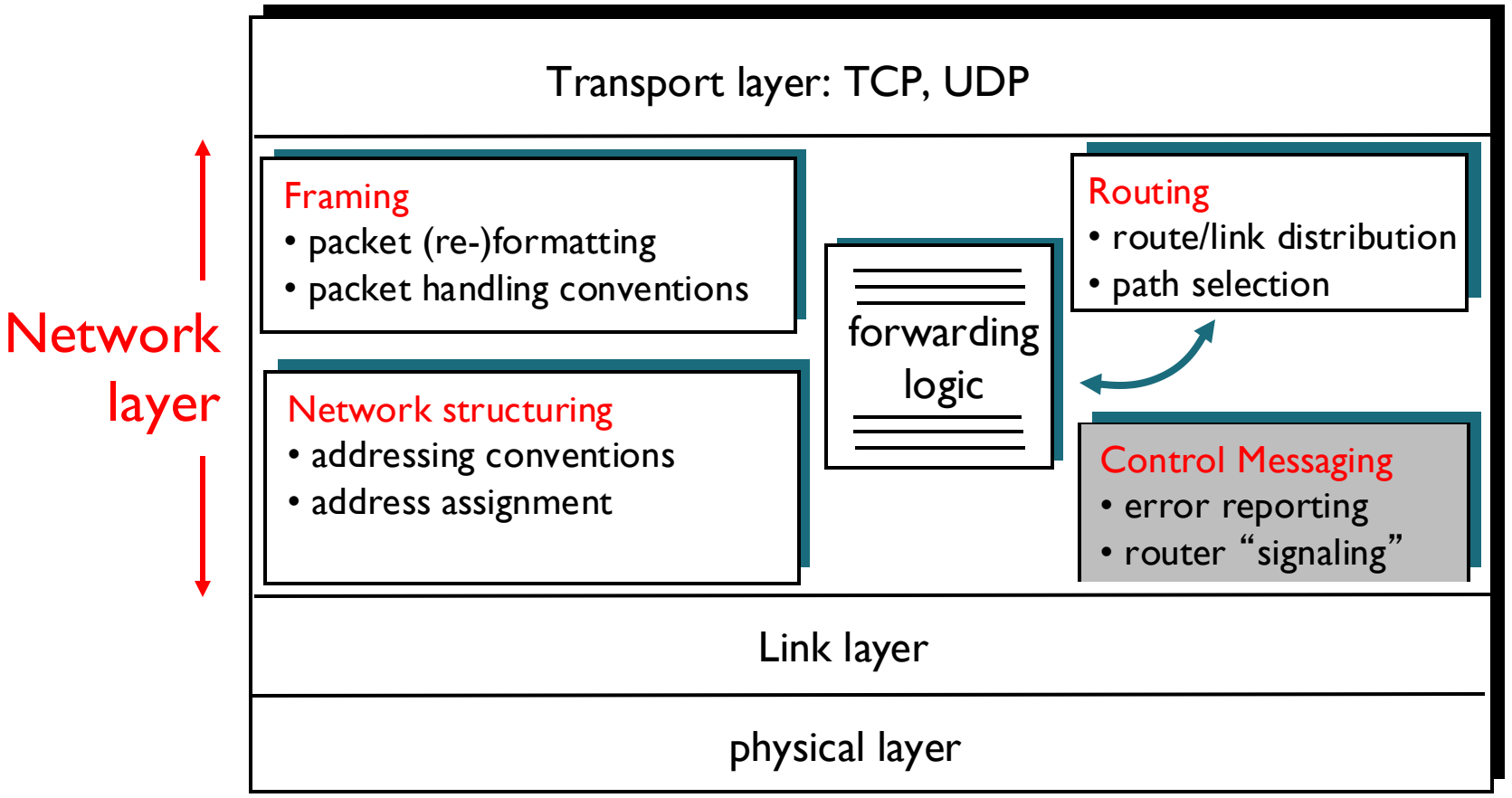


Chapter 5
Network Layer : Control Plane

Computer Networking: A Top-Down Approach
8th Edition, 2020, Pearson,
James F. Kurose, Keith W. Ross

Control Messaging

Host & router network layer functions:



Chapter 5: Control Plane

5.1 Introduction

5.2 Routing protocols

- Link state protocols
- Distance vector protocols

5.3 Intra-AS routing in the Internet: OSPF

5.4 Routing among the ISPs: BGP

5.5 The SDN control plane

5.6 ICMP: The Internet Control Message Protocol

5.7 Network management and SNMP

ICMP : Internet Control Message Protocol

ICMP provides diagnostic mechanisms for:

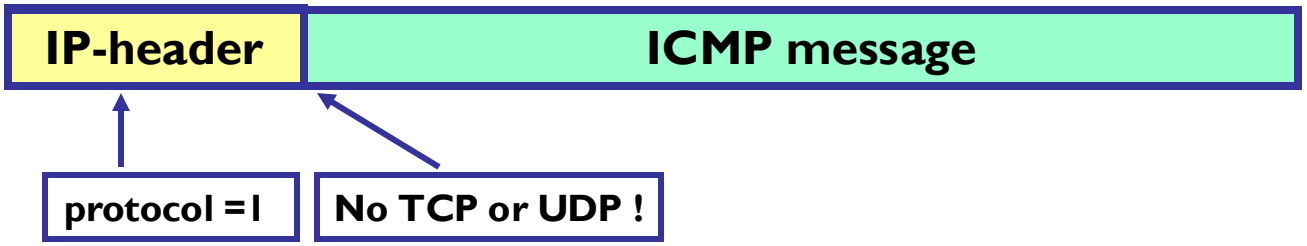
1. End-host reachability
    1. Liveness
    2. Round-trip time to end-host
2. Resolving routing issues
    - Resolving route redirection
3. Route discovery
    - Intermediate hops
4. Other (congestion notification, time sync, ...)

Application in tools:

- PING
- FORWARDING PROCESS IN ROUTER
- TRACEROUTE

tools rely on particular ICMP messages

IP-datagram



icmp is geen tcp / udp, er wordt een protocol waarde 1 gebruikt om aan te geven dat het ene icmp bericht is

ICMP is often considered part of the IP layer

icmp: is een diagnostisch protocol dat vaak als onderdeel van de ip-laag wordt beschouwd
-: end-host bereikbaarheid: checkt of een host bereikbaar is en bepaalt de levensduur van de verbinding en de round trip tijd naar d endhost

-: oplossen van routing issures: zoals route-omleiding

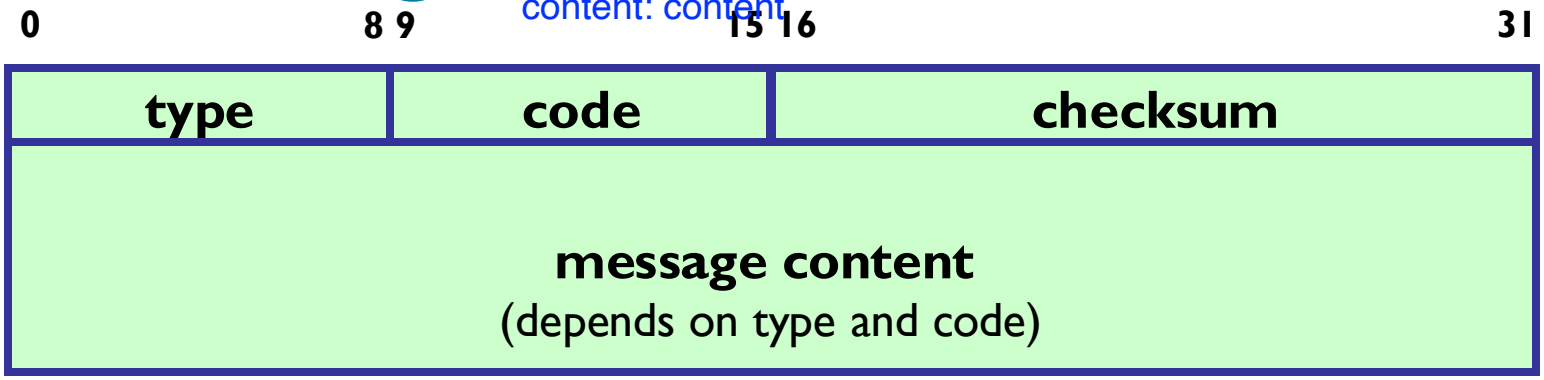
-: routedetectie: informatie verschaffen over tussenliggende hops naar een bestemming

-: meldingen zoals congestiemeldingen en tijdsync

ping en traceroute maken gebruiken van icmp om netwerk diagnoses uit t evoeren

ICMP Message

type: bepaalt de soort icmp
code: specificeert eht subtympe van het bericht
checksum: controlemech om de integriteit van het bericht te waarborgen
content: content



ERROR :

type = 3 : destination unreachable
code = 0 : network unreachable
code = 1 : host unreachable
code = 2 : protocol unreachable
code = 3 : port unreachable
code = 4 : fragmentation needed but dont-fragment bit set
…
type = 5 : redirect
code = 0 : redirect for network
code = 1 : redirect for host
…
type = 11 : time exceeded
code = 0 : TTL = 0 during transit
code = 1 : TTL = 0 during reassembly

QUERY / ANSWER:

type = 0, code = 0 : echo reply
type = 8, code = 0 : echo request
type = 9, code = 0 : router advertisement
type = 10, code = 0 : router solicitation
…

PING

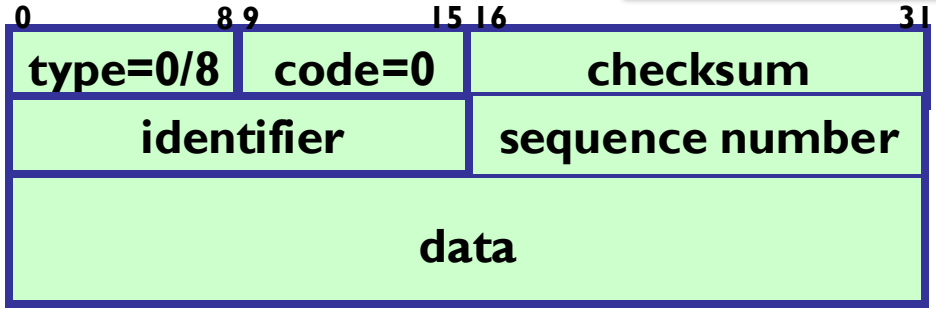
FORWARDING PROCESS IN ROUTER

TRACEROUTE

ICMP query : Echo

PING

type 8 code 0: echo request (ping verzoek)
type 0 code 3: echo reply (ping antwoord)



-n :count : aantal verzoeken dat moeten verzonden worden
-l: size: grootte van de geg in bytes
-i TTL: levensduur van het pakket

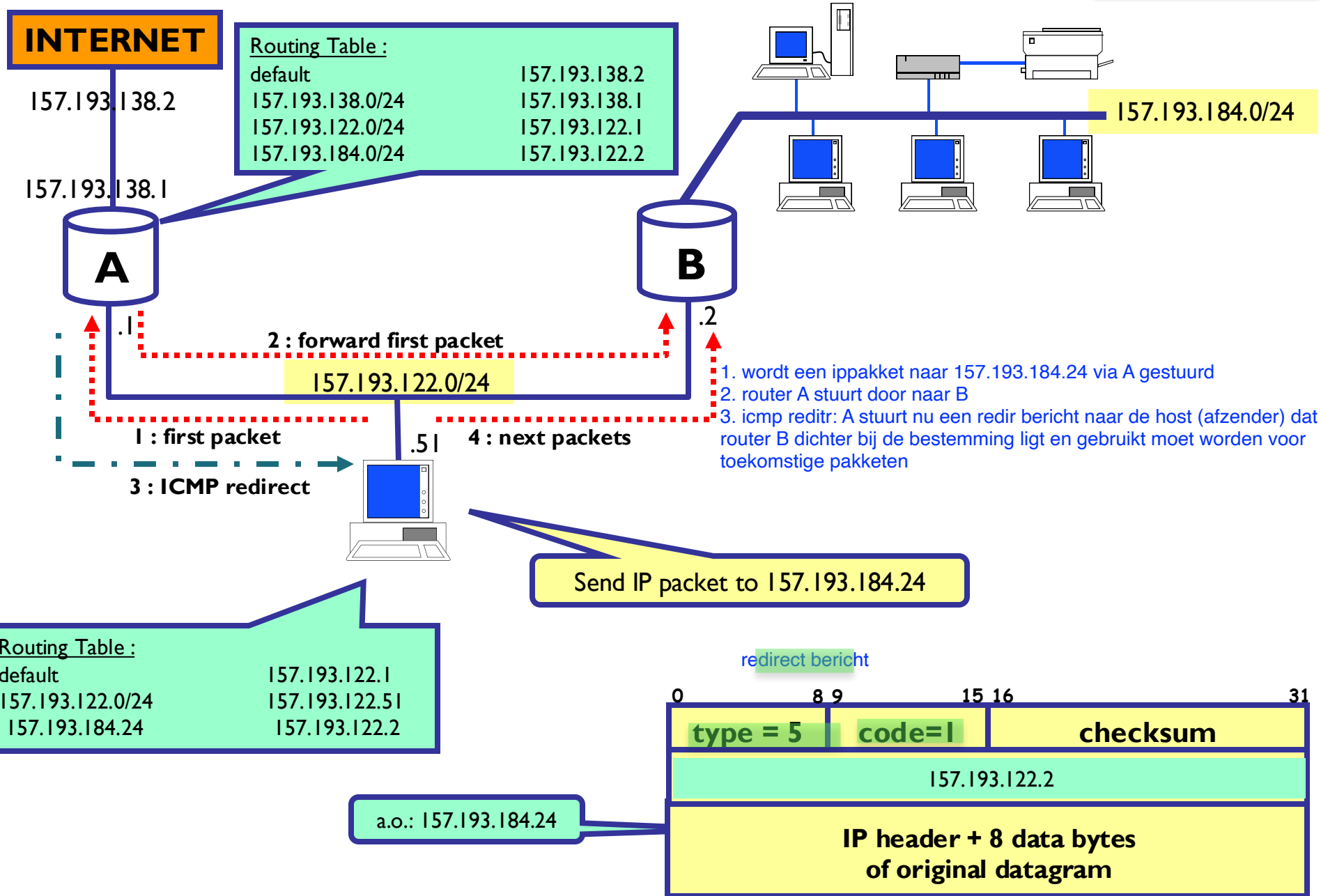
```
C:\WINDOWS>ping
Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]

$ ping -n 5 -l 1500 www.google.com
Pinging www.google.com [74.125.224.82] with 1500 bytes of data:
Reply from 74.125.224.82: bytes=1500 time=68ms TTL=52
Reply from 74.125.224.82: bytes=1500 time=68ms TTL=52
Reply from 74.125.224.82: bytes=1500 time=65ms TTL=52
Reply from 74.125.224.82: bytes=1500 time=66ms TTL=52
Reply from 74.125.224.82: bytes=1500 time=70ms TTL=52
Ping statistics for 74.125.224.82:
        Packets: Sent = 5, Received = 5, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
        Minimum = 65ms, Maximum = 70ms, Average = 67ms
```

redirect: host informeren over een efficientere route nar een bestemming

FORWARDING PROCESS IN ROUTER

ICMP error : Redirect

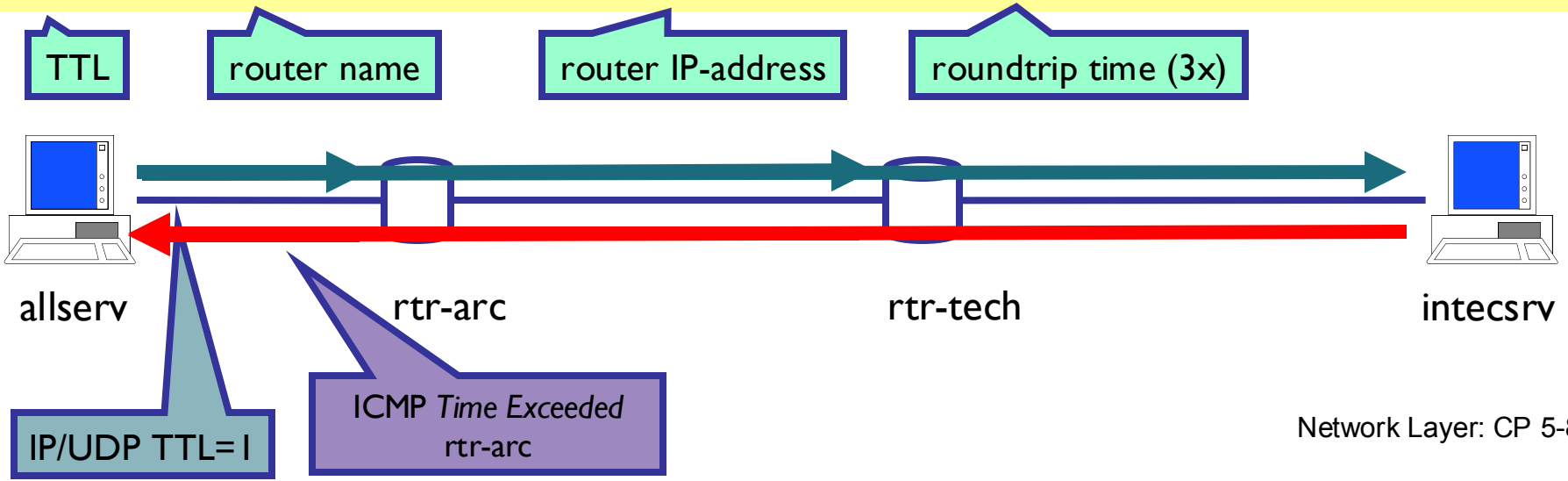


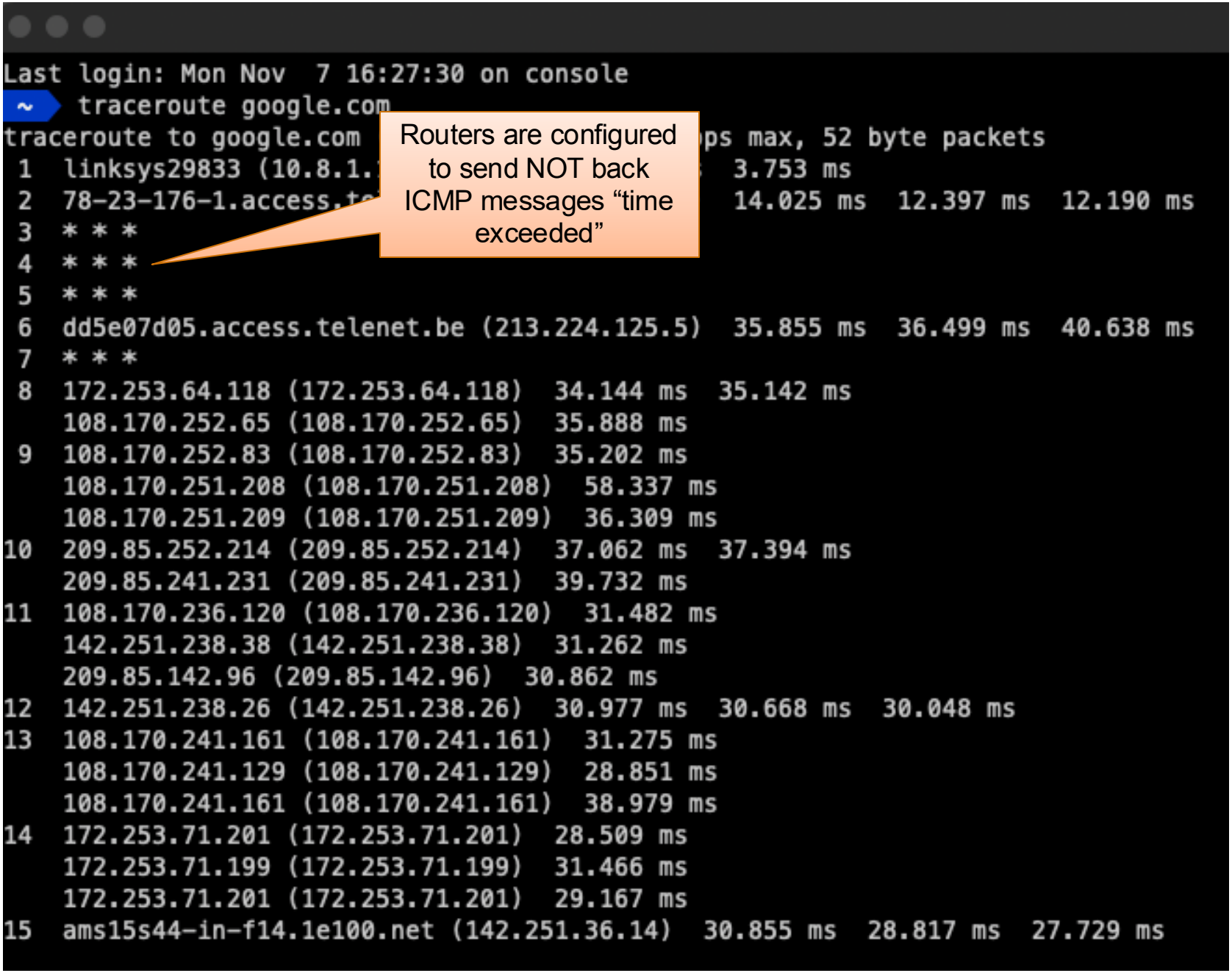
ICMP error : Time Exceeded

GOAL : find-out the route to a destination (and some additional info)

- host running traceroute sends UDP IP-packet to destination with TTL = 1
- first router : decrement TTL to 0, discard packet, ICMP time exceeded back
- hosts sends UDP IP-packet to destination with TTL = 2
- first router : decrement TTL to 1, second router : decrement TTL to 0, discard packet, ICMP time exceeded back
- ...

```
allserv:/staff/ftwe/pdemeest$ traceroute www.intec.ugent.be
traceroute to intecsrv.ugent.be (157.193.92.92), 30 hops max, 40 byte
packets
 1  rtr-arc.ugent.be  (157.193.40.254)  1 ms  1 ms  1 ms
 2  rtr-tech.ugent.be (157.193.138.10)  1 ms  1 ms  1 ms
 3  intecsrv.ugent.be (157.193.92.92)   4 ms  1 ms  3 ms
```




Last login: Mon Nov 7 16:27:30 on console
~ traceroute google.com
traceroute to google.com ps max, 52 byte packets
1 linksys29833 (10.8.1. 3.753 ms
2 78-23-176-1.access.te 14.025 ms 12.397 ms 12.190 ms
3 * * *
4 * * *
5 * * *
6 dd5e07d05.access.telenet.be (213.224.125.5) 35.855 ms 36.499 ms 40.638 ms
7 * * *
8 172.253.64.118 (172.253.64.118) 34.144 ms 35.142 ms
108.170.252.65 (108.170.252.65) 35.888 ms
9 108.170.252.83 (108.170.252.83) 35.202 ms
108.170.251.208 (108.170.251.208) 58.337 ms
108.170.251.209 (108.170.251.209) 36.309 ms
10 209.85.252.214 (209.85.252.214) 37.062 ms 37.394 ms
209.85.241.231 (209.85.241.231) 39.732 ms
11 108.170.236.120 (108.170.236.120) 31.482 ms
142.251.238.38 (142.251.238.38) 31.262 ms
209.85.142.96 (209.85.142.96) 30.862 ms
12 142.251.238.26 (142.251.238.26) 30.977 ms 30.668 ms 30.048 ms
13 108.170.241.161 (108.170.241.161) 31.275 ms
108.170.241.129 (108.170.241.129) 28.851 ms
108.170.241.161 (108.170.241.161) 38.979 ms
14 172.253.71.201 (172.253.71.201) 28.509 ms
172.253.71.199 (172.253.71.199) 31.466 ms
172.253.71.201 (172.253.71.201) 29.167 ms
15 ams15s44-in-f14.1e100.net (142.251.36.14) 30.855 ms 28.817 ms 27.729 ms
Routers are configured to send NOT back ICMP messages “time exceeded”