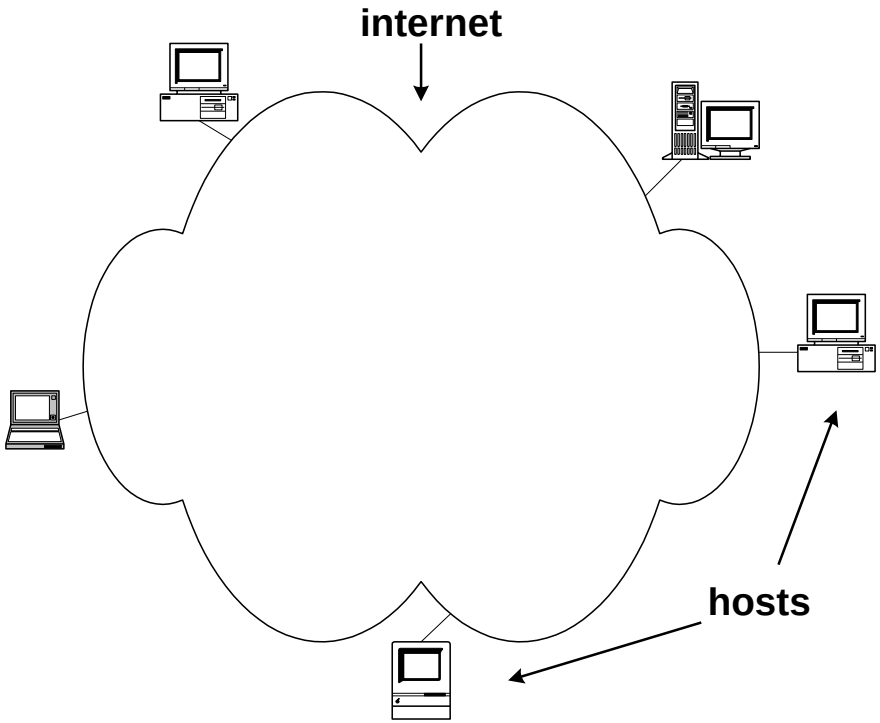
Introdução às Redes IP

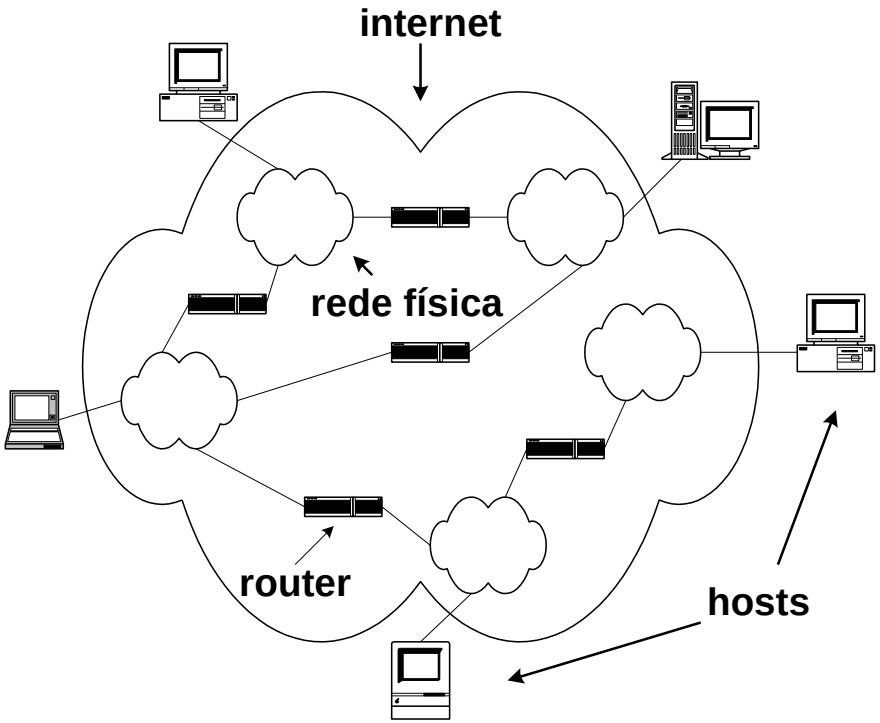
Redes de Comunicações 1

Licenciatura em Engenharia de Computadores e Informática

DETI-UA

A Internet





Internet: História

Data	Evento
1960	Proposta para uma rede militar à prova de bombas.
1969	Advanced Research Project Agency (ARPA) financia ID em redes distribuídas
1972	ARPANET: primeiro email
1973	UK e Noruega ligam-se à ARPANET
1974	Primeira versão do Transmission Control Protocol (TCP)
1983	TCP Internet Protocol (TCP/IP) aceite como standard
1984	DNS introduzido
1990	ARPANET torna-se em INTERNET
1992	Central European Research Network (CERN) cria a norma de hipertexto (HTML): surgimento da Word Wide Web (WWW).
1993	Mosaic, seguida pelo Netscape, tornam-se as ferramentas habituais na Internet
1996	Comunicação multimédia vulgarizada

Internet: História

Data	Evento
1997	Netflix: vender DVDs por correio
1998	Google
1998	IPv6
1999	Peer-2-peer com Napster (música)
2004	Facebook
2005	Youtube.com
2006	Twitter
2010	Pinterest e Instagram
2016	Google assistant (ativação voz)
2018	IoT (7M dispositivos)
2019	5G
2021	4.66B pessoas ligadas à Internet (mais de metade da população global)
2022	Satélites LEO (Low-Orbit) - Starlink

Rede daqui até… (2021)

China

```
C:\Users\Susana>tracert www.zju.edu.cn

Tracing route to www.zju.edu.cn [61.164.42.190]
over a maximum of 30 hops:

  1     3 ms     3 ms     1 ms  staff-4062.wireless.ua.pt [192.168.3
  2     3 ms     2 ms     2 ms  10.1.0.6
  3     3 ms     4 ms     6 ms  193.137.173.243
  4     8 ms    12 ms     7 ms  Router2.Campanha.fccn.pt [193.136.4.
  5     9 ms    14 ms    23 ms  Router3.10GE.DWDM.Lisboa.fccn.pt [19
  6    22 ms    18 ms    18 ms  ROUTER4.10GE.CR2.Lisboa.fccn.pt [193
  7    10 ms     9 ms     7 ms  fccn.mx2.lis.pt.geant.net [62.40.124
  8    25 ms    20 ms    19 ms  xe-2-3-0.rt1.mad.es.geant.net [62.40
  9   111 ms    66 ms    42 ms  xe-2-0-0.mx1.gen.ch.geant.net [62.40
 10    49 ms    49 ms    47 ms  ae1.mx1.fra.de.geant.net [62.40.98.1
 11    49 ms     *      103 ms  xe-8-0-1.edge5.Frankfurt1.Level3.net
9]
 12   193 ms   195 ms   228 ms  vlan60.csw1.Frankfurt1.Level3.net [4

 13   196 ms   194 ms   257 ms  ae-62-62.ebr2.Frankfurt1.Level3.net
]
 14   206 ms   249 ms   234 ms  ae-22-22.ebr2.London1.Level3.net [4.

 15   194 ms   229 ms   196 ms  ae-44-44.ebr1.NewYork1.Level3.net [4

 16   201 ms   196 ms   193 ms  ae-91-91.csw4.NewYork1.Level3.net [4

 17   197 ms   208 ms   198 ms  ae-92-92.ebr2.NewYork1.Level3.net [4

 18   196 ms   196 ms   194 ms  ae-2-2.ebr1.SanJose1.Level3.net [4.6
 19   195 ms   195 ms   195 ms  ae-81-81.csw3.SanJose1.Level3.net [4

 20   198 ms   194 ms   194 ms  ae-3-80.edge2.SanJose3.Level3.net [4

 21     *      201 ms   198 ms  CHINA-TELEC.edge2.SanJose3.Level3.ne
114]
 22   196 ms   200 ms   202 ms  202.97.51.9
 23   396 ms   399 ms   406 ms  202.97.50.89
 24   426 ms   424 ms   418 ms  202.97.33.121
 25   494 ms   469 ms   464 ms  202.97.33.13
 26     *        *        *     Request timed out.
 27   471 ms     *      486 ms  61.164.5.62
 28   441 ms   442 ms   449 ms  61.164.4.54
 29   477 ms   442 ms   480 ms  115.236.178.234
 30   447 ms   448 ms   447 ms  61.164.42.190

Trace complete.
```

Austrália

```
C:\Users\Susana>tracert www.adelaide.edu.au

Tracing route to online-media.adelaide.edu.au [129.127.144.141]
over a maximum of 30 hops:

  1     7 ms     8 ms    12 ms  staff-4063.wireless.ua.pt [192.168.31.253]
  2    15 ms     6 ms    10 ms  10.1.0.6
  3    14 ms    18 ms    13 ms  193.137.173.243
  4    28 ms    14 ms    12 ms  Router2.Campanha.fccn.pt [193.136.4.26]
  5    38 ms    13 ms    16 ms  Router3.10GE.DWDM.Lisboa.fccn.pt [193.136.1.1]
  6    12 ms    10 ms   196 ms  ROUTER4.10GE.CR2.Lisboa.fccn.pt [193.137.0.20]
  7    15 ms    23 ms    29 ms  fccn.mx2.lis.pt.geant.net [62.40.124.97]
  8    31 ms    42 ms    38 ms  xe-2-3-0.rt1.mad.es.geant.net [62.40.98.107]
  9   173 ms   212 ms   146 ms  mb-so-02-v4.bb.tein3.net [202.179.249.117]
 10   190 ms   194 ms   198 ms  sg-so-04-v4.bb.tein3.net [202.179.249.53]
 11   194 ms   199 ms   198 ms  au-pr-v4.bb.tein3.net [202.179.249.62]
 12   412 ms   337 ms   340 ms  so-4-1-0.bb1.b.syd.aarnet.net.au [202.158.194.24
4]
 13   339 ms   363 ms   340 ms  so-0-1-0.bb1.b.cbr.aarnet.net.au [202.158.194.30
]
 14   342 ms   395 ms   341 ms  ge-0-0-0.bb1.a.cbr.aarnet.net.au [202.158.194.20
5]
 15   351 ms   349 ms   351 ms  so-0-1-0.bb1.b.mel.aarnet.net.au [202.158.194.42
]
 16   348 ms   347 ms   347 ms  ge-0-0-0.bb1.a.mel.aarnet.net.au [202.158.194.18
1]
 17     *      358 ms   355 ms  so-2-0-0.bb1.a.adl.aarnet.net.au [202.158.194.17
]
 18   363 ms   356 ms   357 ms  xe-0-0-0.er2.adelaide.cpe.aarnet.net.au [202.158
.199.42]
 19   357 ms   354 ms   382 ms  gw2.er2.adelaide.cpe.aarnet.net.au [202.158.199.
114]
 20     *        *        *     Request timed out.
 21     *        *        *     Request timed out.
 22     *        *        *     Request timed out.
 23   361 ms   353 ms   359 ms  online-media.adelaide.edu.au [129.127.144.141]

Trace complete.
```

http://hostip.info/

Rede daqui até… (2021->2024)

```
C:\Users\Susana>tracert www.zju.edu.cn

Tracing route to www.zju.edu.cn [61.164.42.190]
over a maximum of 30 hops:

  1     3 ms     3 ms     1 ms  staff-4062.wireless.ua.pt [192.168.31.252]
  2     3 ms     2 ms     2 ms  10.1.0.6
  3     3 ms     4 ms     6 ms  193.137.173.243
  4     8 ms    12 ms     7 ms  Router2.Campanha.fccn.pt [193.136.4.26]
  5     9 ms    14 ms    23 ms  Router3.10GE.DWDM.Lisboa.fccn.pt [193.136.1.1]
  6    22 ms    18 ms    18 ms  ROUTER4.10GE.CR2.Lisboa.fccn.pt [193.137.0.20]
  7    10 ms     9 ms     7 ms  fccn.mx2.lis.pt.geant.net [62.40.124.97]
  8    25 ms    20 ms    19 ms  xe-2-3-0.rt1.mad
  9   111 ms    66 ms    42 ms  xe-2-0-0.mx1.gen
 10    49 ms    49 ms    47 ms  ae1.mx1.fra.de.g
 11    49 ms     *      103 ms  xe-8-0-1.edge5.F
9]
 12   193 ms   195 ms   228 ms  vlan60.csw1.Fran

 13   196 ms   194 ms   257 ms  ae-62-62.ebr2.Fr
]
 14   206 ms   249 ms   234 ms  ae-22-22.ebr2.Lo

 15   194 ms   229 ms   196 ms  ae-44-44.ebr1.Ne

 16   201 ms   196 ms   193 ms  ae-91-91.csw4.Ne

 17   197 ms   208 ms   198 ms  ae-92-92.ebr2.Ne

 18   196 ms   196 ms   194 ms  ae-2-2.ebr1.SanJ
 19   195 ms   195 ms   195 ms  ae-81-81.csw3.Sa

 20   198 ms   194 ms   194 ms  ae-3-80.edge2.Sa

 21     *      201 ms   198 ms  CHINA-TELEC.edge
114]
 22   196 ms   200 ms   202 ms  202.97.51.9
 23   396 ms   399 ms   406 ms  202.97.50.89
 24   426 ms   424 ms   418 ms  202.97.33.121
 25   494 ms   469 ms   464 ms  202.97.33.13
 26     *        *        *     Request timed out.
 27   471 ms     *      486 ms  61.164.5.62
 28   441 ms   442 ms   449 ms  61.164.4.54
 29   477 ms   442 ms   480 ms  115.236.178.234
 30   447 ms   448 ms   447 ms  61.164.42.190

Trace complete.
```

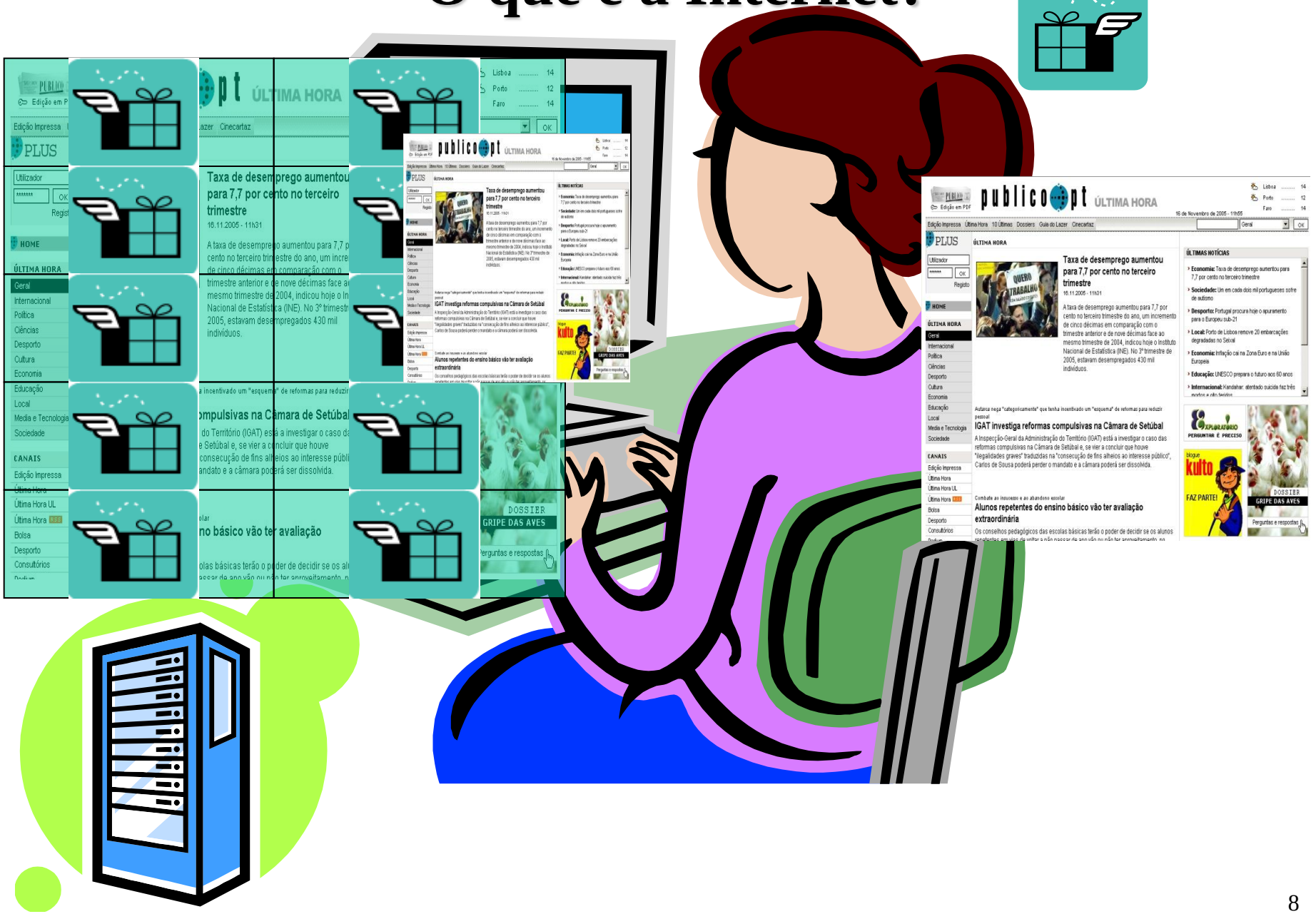
```
C:\Users\user>tracert -4 www.zju.edu.cn

Tracing route to www.zju.edu.cn.queniusa.com [163.181.50.229]
over a maximum of 30 hops:

  1     2 ms     6 ms     8 ms  GEN8 [192.168.1.254]
  2     *        *        *     Request timed out.
  3     *        *        8 ms  telepac16-hsi.cprm.net [195.8.30.250]
  4    22 ms     6 ms     9 ms  tva-cr1-be10-200.cprm.net [195.8.30.249]
  5    24 ms    19 ms    15 ms  lis2-cr1-be5.cprm.net [195.8.0.153]
  6    32 ms    15 ms    13 ms  ae19.lisbona1.lis.seabone.net [213.144.187.236]
  7    49 ms    45 ms    59 ms  ae10.milano58.mil.seabone.net [195.22.208.117]

  8    47 ms     *        *     Request timed out.il.seabone.net [93.186.128.78]
 10    46 ms    45 ms    44 ms  163.181.50.229

Trace complete.
```

Rede daqui até… (2021->2024)

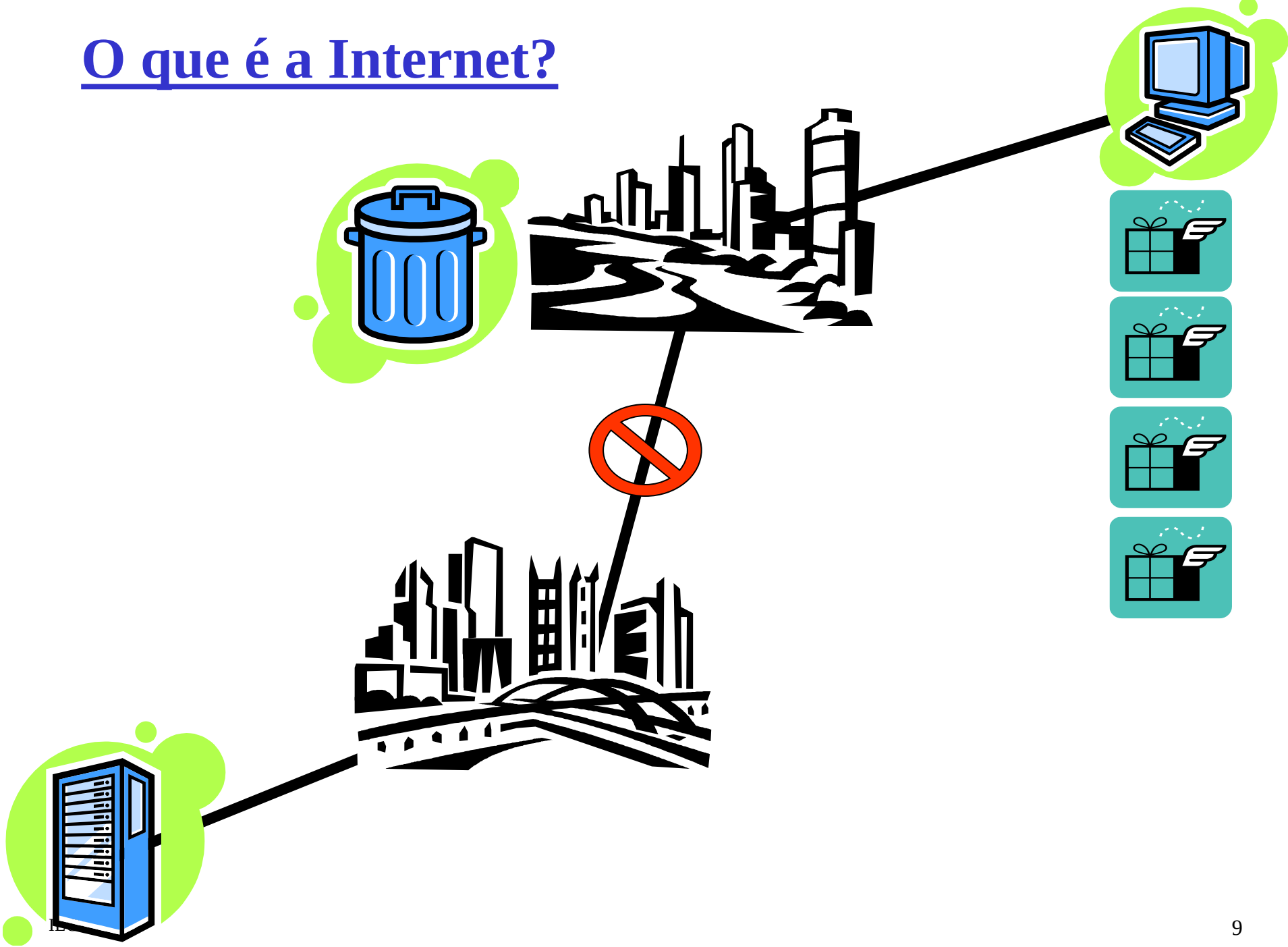
```
C:\Users\Susana>tracert www.adelaide.edu.au

Tracing route to online-media.adelaide.edu.au [129.127.144.141]
over a maximum of 30 hops:

  1     7 ms     8 ms    12 ms  staff-4063.wireless.ua.pt [192.168.31.253]
  2    15 ms     6 ms    10 ms  10.1.0.6
  3    14 ms    18 ms    13 ms  193.137.173.243
  4    28 ms    14 ms    12 ms  Router2.Campanha.fccn.pt [193.136.4.26]
  5    38 ms    13 ms    16 ms  Router3.10GE.DWDM.Lisboa.fccn.pt [193.136.1.1]
  6    12 ms    10 ms   196 ms  ROUTER4.10GE.CR2.Lisboa.fccn.pt [193.137.0.20]
  7    15 ms    23 ms    29 ms  fccn.mx2.lis.pt.geant.net [62.40.124.97]
  8    31 ms    42 ms    38 ms  xe-2-3-0.rt1.mad.es.geant.net [62.40.98.107]
  9   173 ms   212 ms   146 ms  mb-so-02-v4.bb.tein3.net [202.179.249.117]
 10   190 ms   194 ms   198 ms  sg-so-04-v4.bb.tein3.net [202.179.249.53]
 11   194 ms   199 ms   198 ms  au-pr-v4.bb.tein3.net [202.179.249.62]
 12   412 ms   337 ms   340 ms  so-4-1-0.bb1.b.syd.aarnet.net.au [202.158.194.24
4]
 13   339 ms   363 ms   340 ms  so-0-1-0.bb1.b.cbr.aarnet.net.au [202.158.194.30
]
 14   342 ms   395 ms   341 ms  ge-0-0-0.bb1.a.cbr.aarnet.net.au [202.158.194.20
5]
 15   351 ms   349 ms   351 ms  so-0-1-0.bb1.b.mel.aarnet.net.au [202.158.194.42
]
 16   348 ms   347 ms   347 ms  ge-0-0-0.bb1.a.mel.aarnet.net.au [202.158.194.18
1]
 17     *      358 ms   355 ms  so-2-0-0.bb1.a.adl.aarnet.net.au [202.158.194.17
]
 18   363 ms   356 ms   357 ms  xe-0-0-0.er2.adelaide.cpe.aarnet.net.au [202.158
.199.42]
 19   357 ms   354 ms   382 ms  gw2.er2.adelaide.cpe.aarnet.net.au [202.158.199.
114]
 20     *        *        *     Request timed out.
 21     *        *        *     Request timed out.
 22     *        *        *     Request timed out.
 23   361 ms   353 ms   359 ms  online-media.adelaide.edu.au [129.127.144.141]

Trace complete.
```

```
>tracert -4 www.adelaide.edu.au

 to online-media.adelaide.edu.au [129.127.149.1]
m of 30 hops:

     5 ms     7 ms  GEN8 [192.168.1.254]
     *        *     Request timed out.
     7 ms     7 ms  telepac15-hsi.cprm.net [195.8.30.246]
    29 ms    15 ms  ga-cr1-be10-200.cprm.net [195.8.30.245]
    32 ms    24 ms  lis2-cr1-be4.cprm.net [195.8.1.57]
    12 ms    13 ms  ae19.lisbona1.lis.seabone.net [213.144.187.236]
   193 ms   213 ms  ae13.paloalto2.pao.seabone.net [195.22.195.25]
     *        *     Request timed out.
  9   449 ms   357 ms   359 ms  xe-1-2-1.pe2.brwy.nsw.aarnet.net.au [202.158.194.1
76]
 10   398 ms   354 ms   360 ms  et-2-1-0.pe1.mcqp.nsw.aarnet.net.au [113.197.15.14
2]
 11   347 ms   367 ms   348 ms  et-0-3-0.pe1.eskp.nsw.aarnet.net.au [113.197.15.3]

 12   372 ms   367 ms   406 ms  et-0-3-0.pe1.prka.sa.aarnet.net.au [113.197.15.42]

 13   376 ms   411 ms   368 ms  adelaide.vlan227.xe-5-1-1.pe1.prka.sa.aarnet.net.a
u [138.44.192.95]
 14     *        *        *     Request timed out.
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17     *        *        *     Request timed out.
 18   379 ms   432 ms   515 ms  online-media.adelaide.edu.au [129.127.149.1]

Trace complete.
```

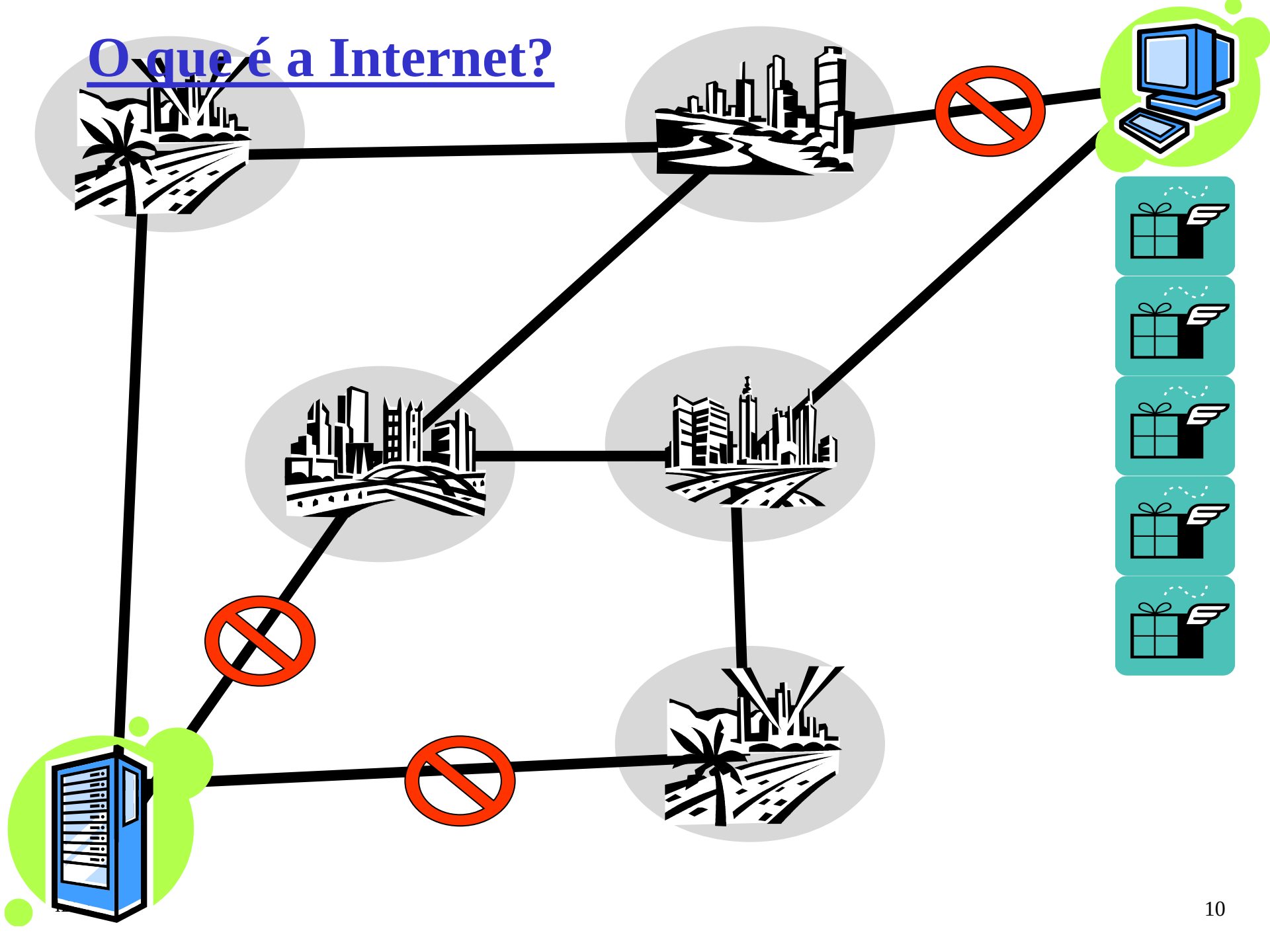
O que é a Internet?



O que é a Internet?



O que é a Internet?



O que é um protocolo?

Protocolos humanos:

- **"Que horas são?"**
- **"Eu tenho uma pergunta!"**

… são enviadas mensagens específicas

… são executadas acções específicas quando são recebidas mensagens

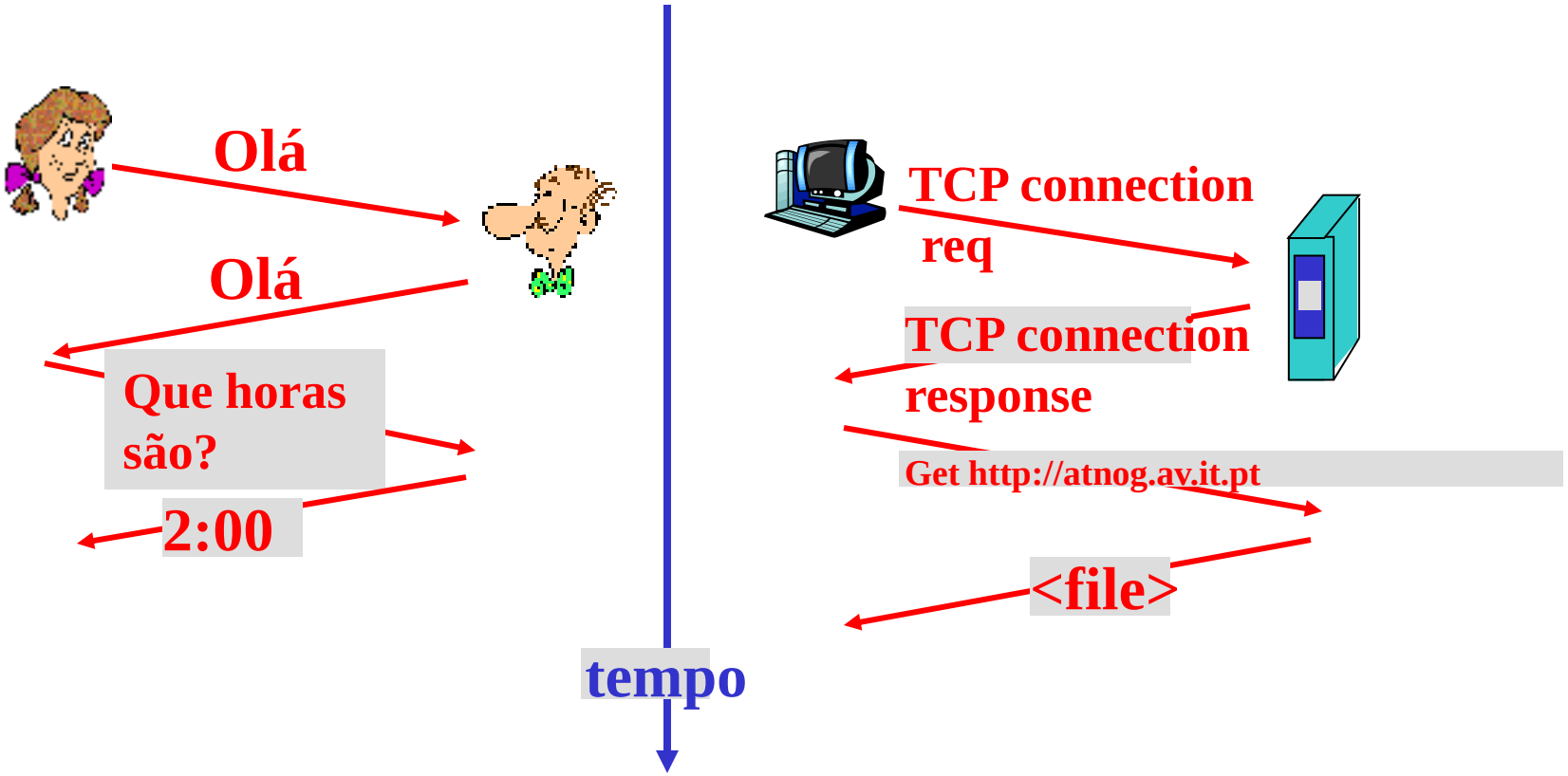
Protocolos de rede:

- **Máquinas em vez de humanos**
- **Todas as comunicações na Internet são exectudas por protocolos**

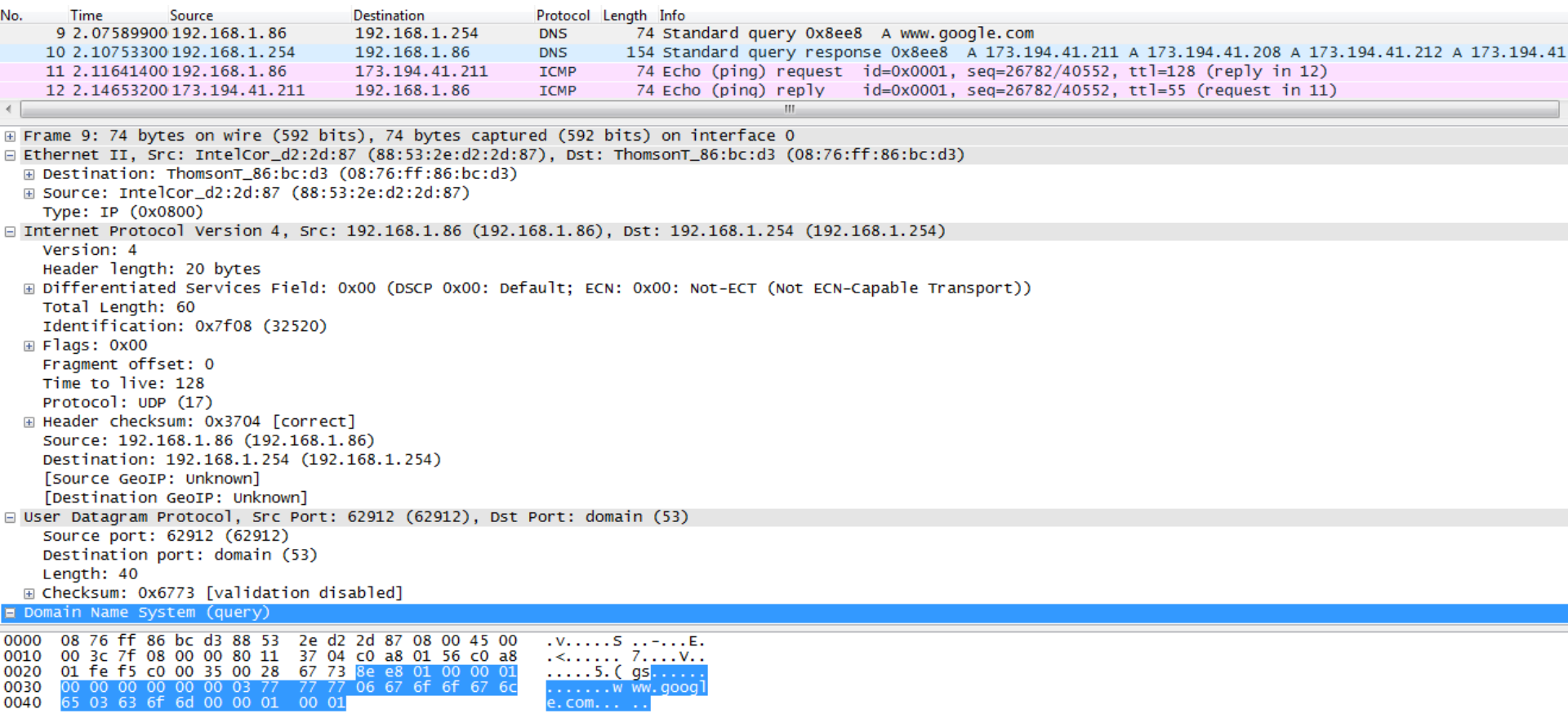
Os protocolos definem o formato e a ordem das mensagens enviadas e recebidas entre as entidades da rede, e as acções executadas quando da transmissão e recepção das mensagens

O que é um protocolo?

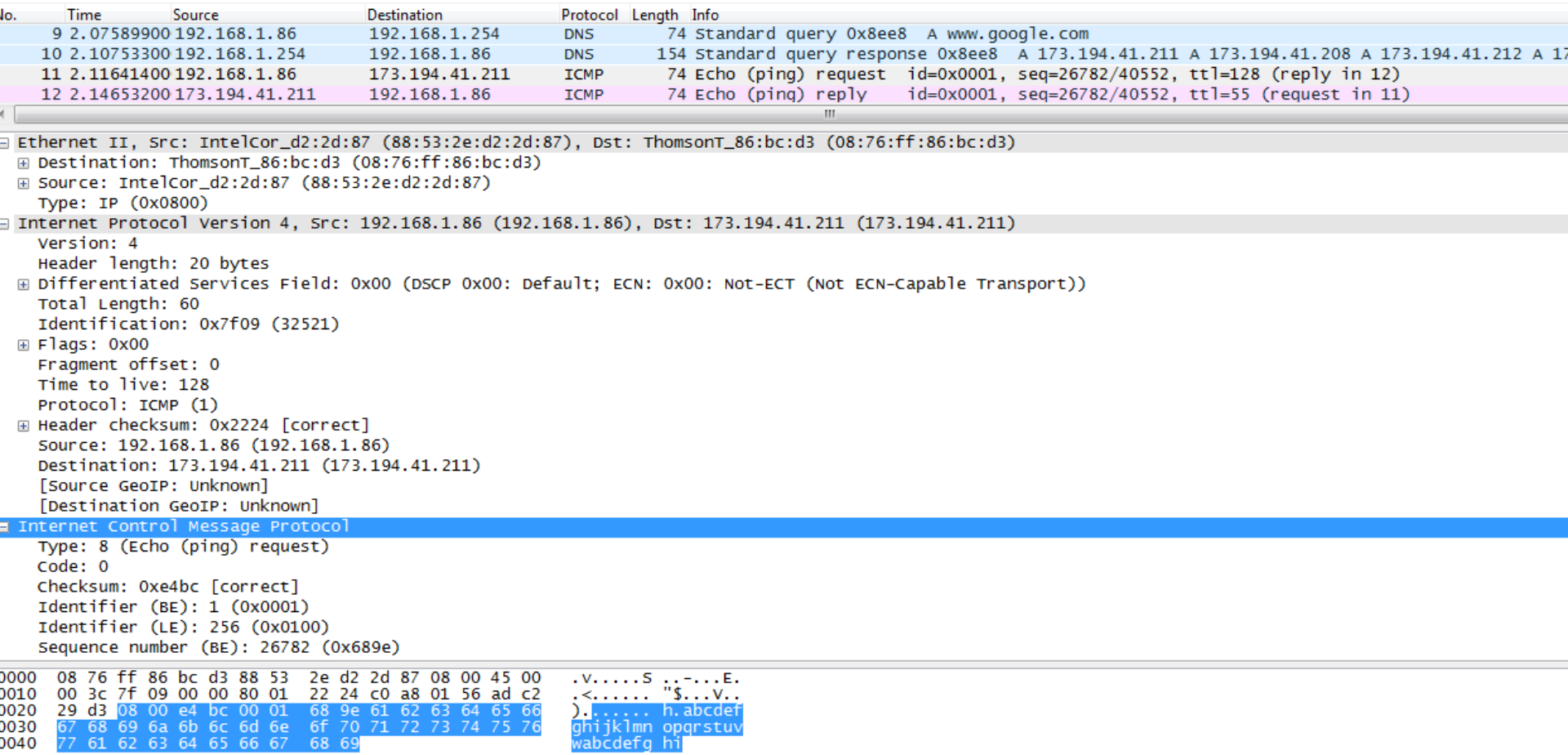
Um protocolo humano e um protocolo de rede:



Pesquisa de endereço google.com

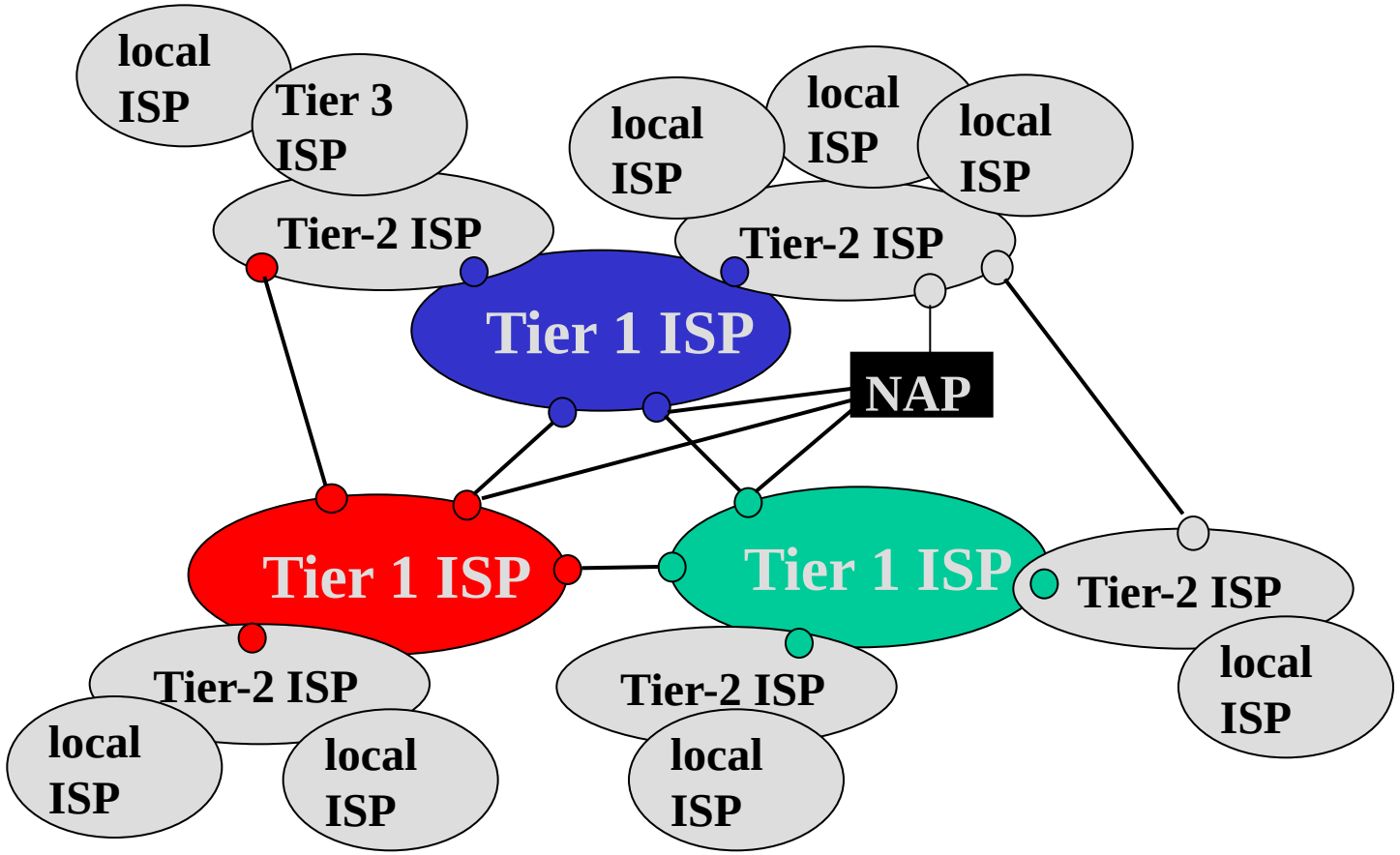


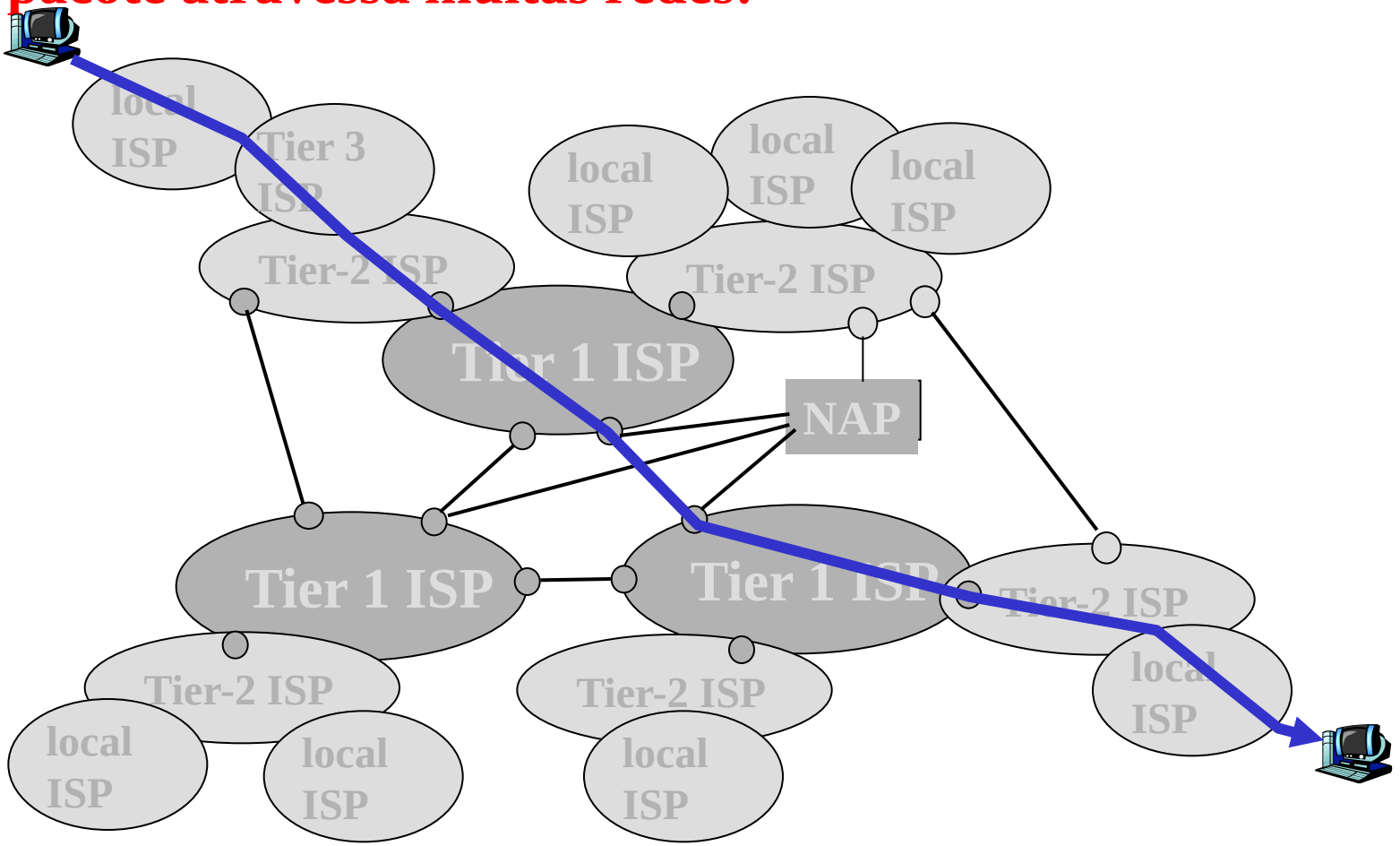
Ping ao google.com



Estrutura da Internet: rede de redes

- **Aproximadamente hierárquica**
- **ISPs de nível 1 (cobertura nacional/internacional, e.g Sprint e AT&T), ISPs de nível 2 (mais pequenos, frequentemente regionais), ISPs de nível 3 e ISPs locais (redes de acesso)**



Estrutura da Internet: rede de redes

- **Um pacote atravessa muitas redes!**