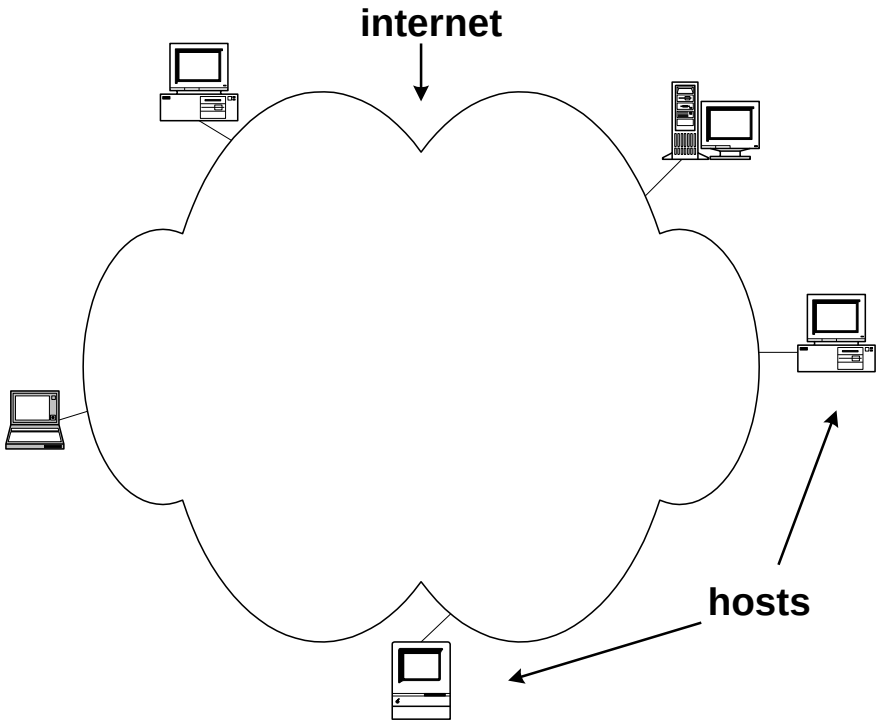
Introdução às Redes IP

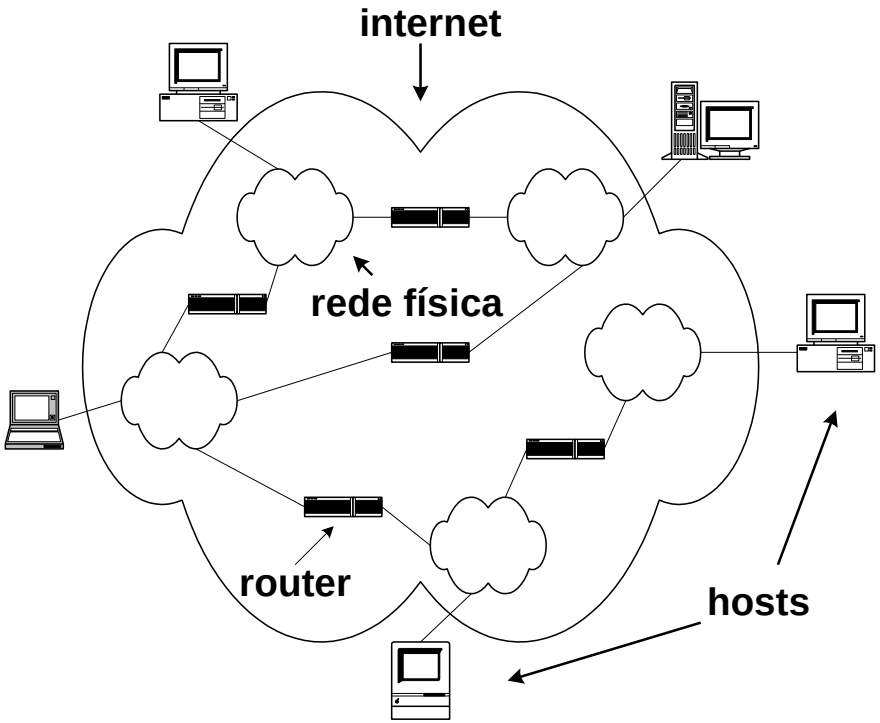
Redes de Comunicações 1

Licenciatura em Engenharia de Computadores e Informática

DETI-UA, 2023/2024

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…

China

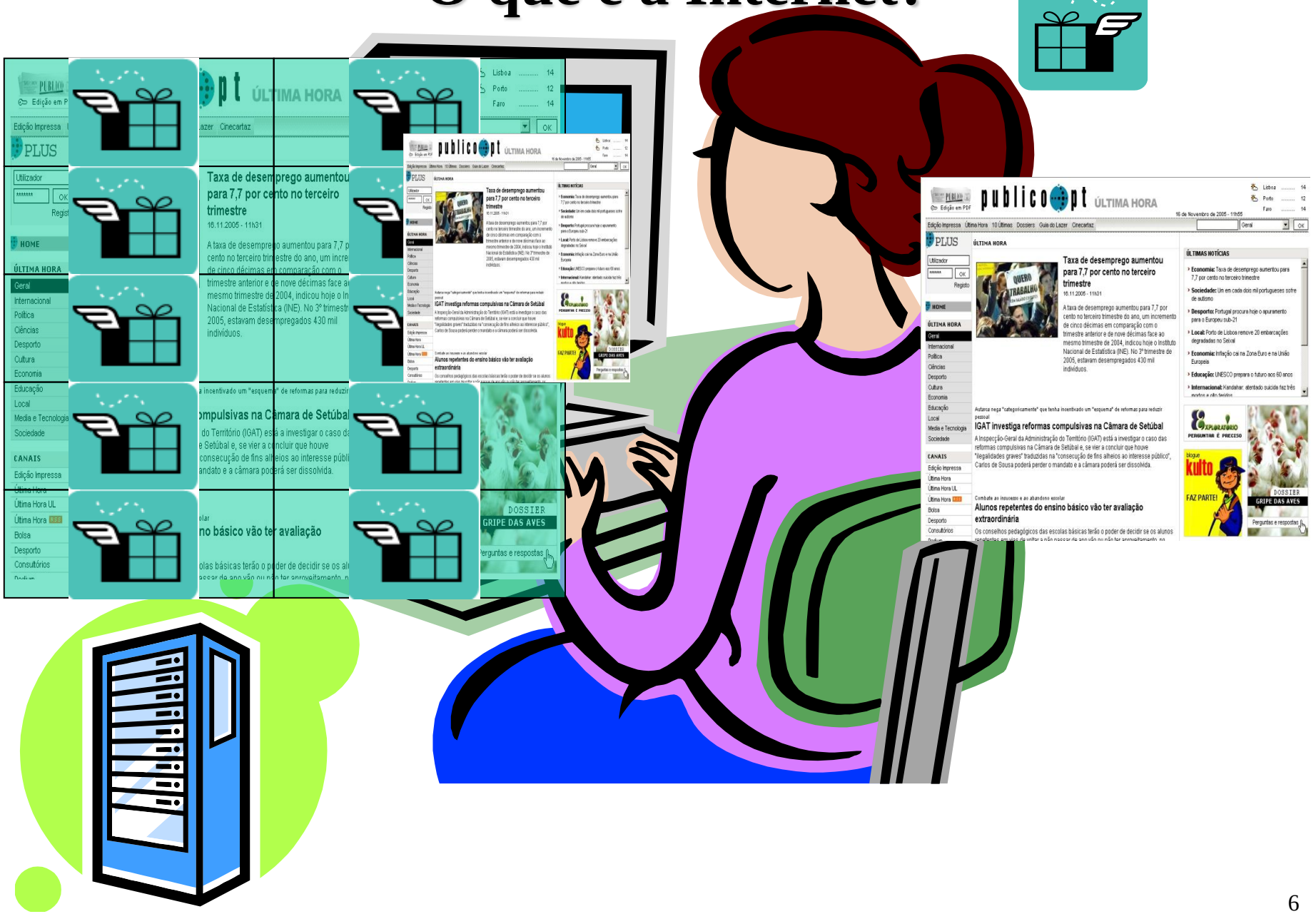
```
C:\Users\Susana>tracert www.zju.edu.cn

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/

O que é a Internet?



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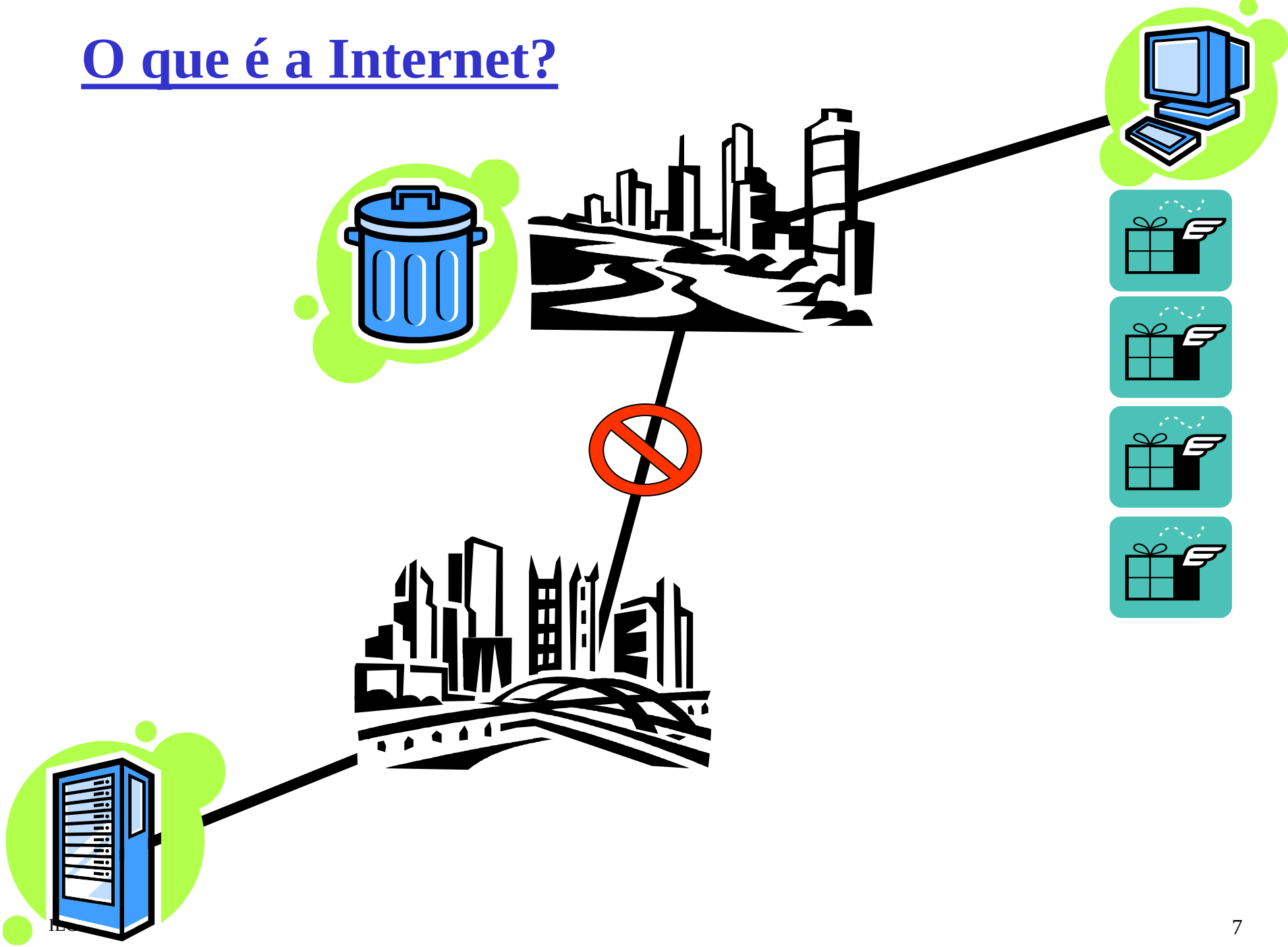

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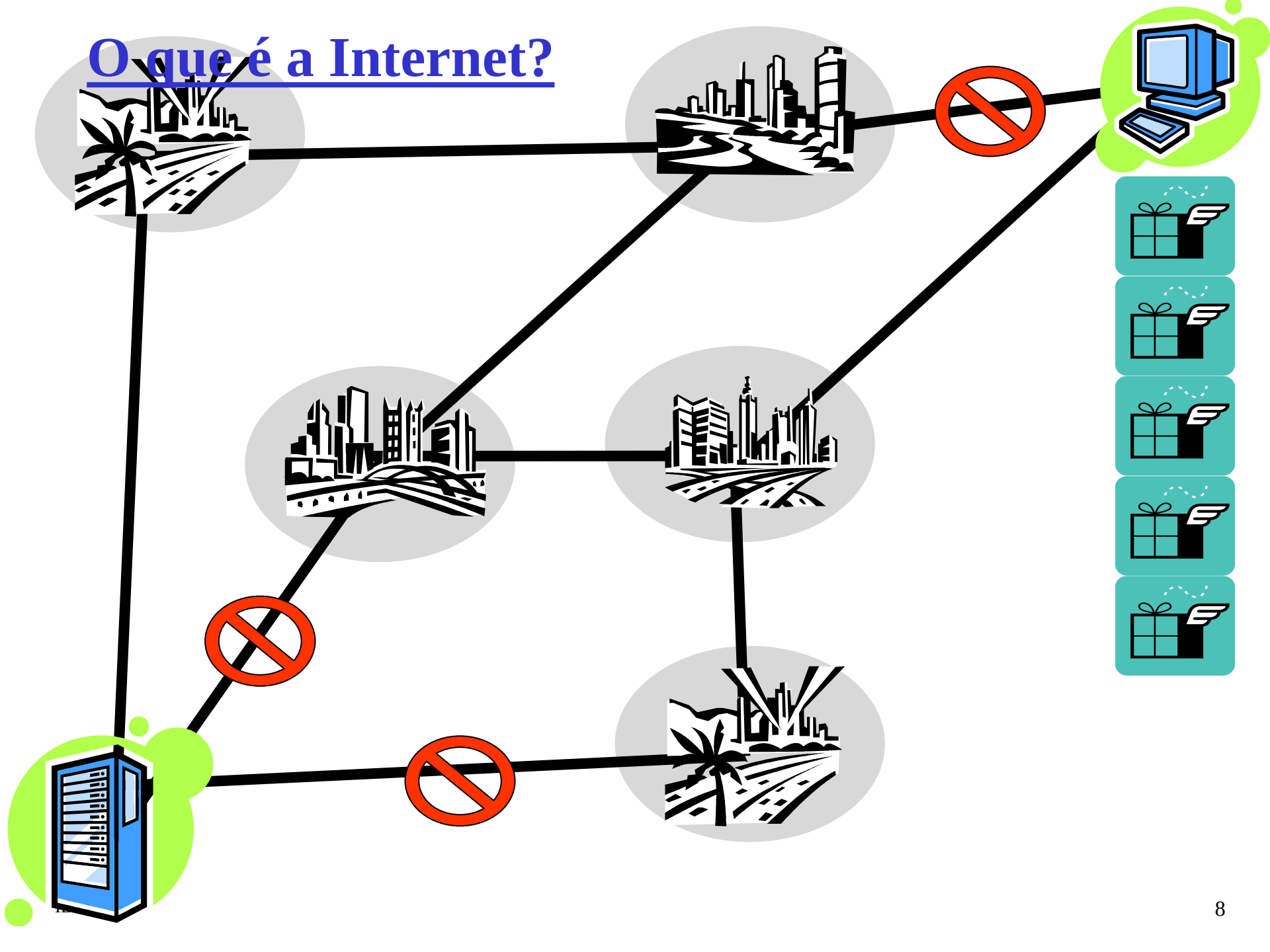


O que é um protocolo?

Protocolos humanos:

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

… são enviadas mensagens específicas

… são executadas acções específicas quando são recebidas mensagens

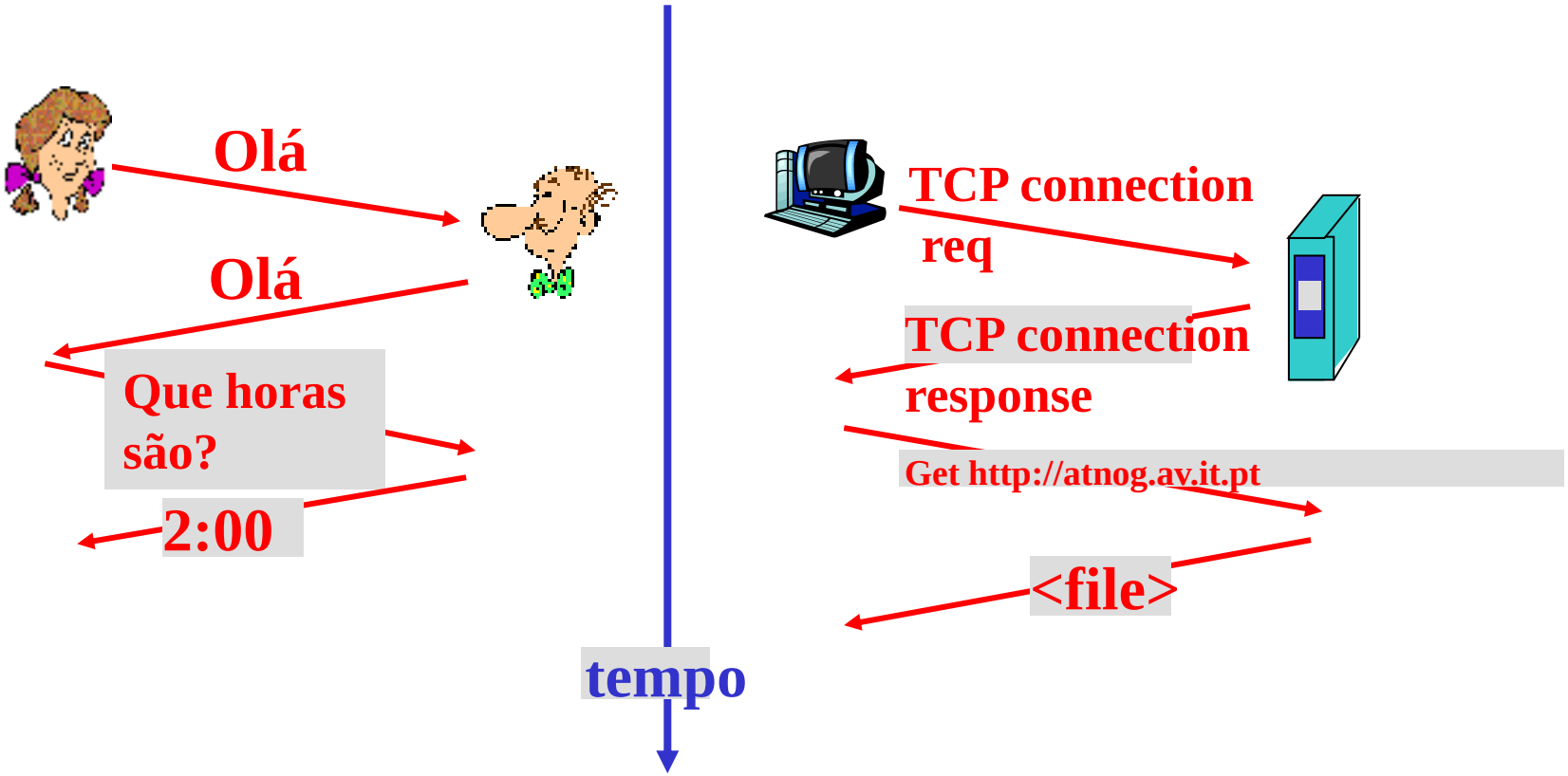
Protocolos de rede:

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

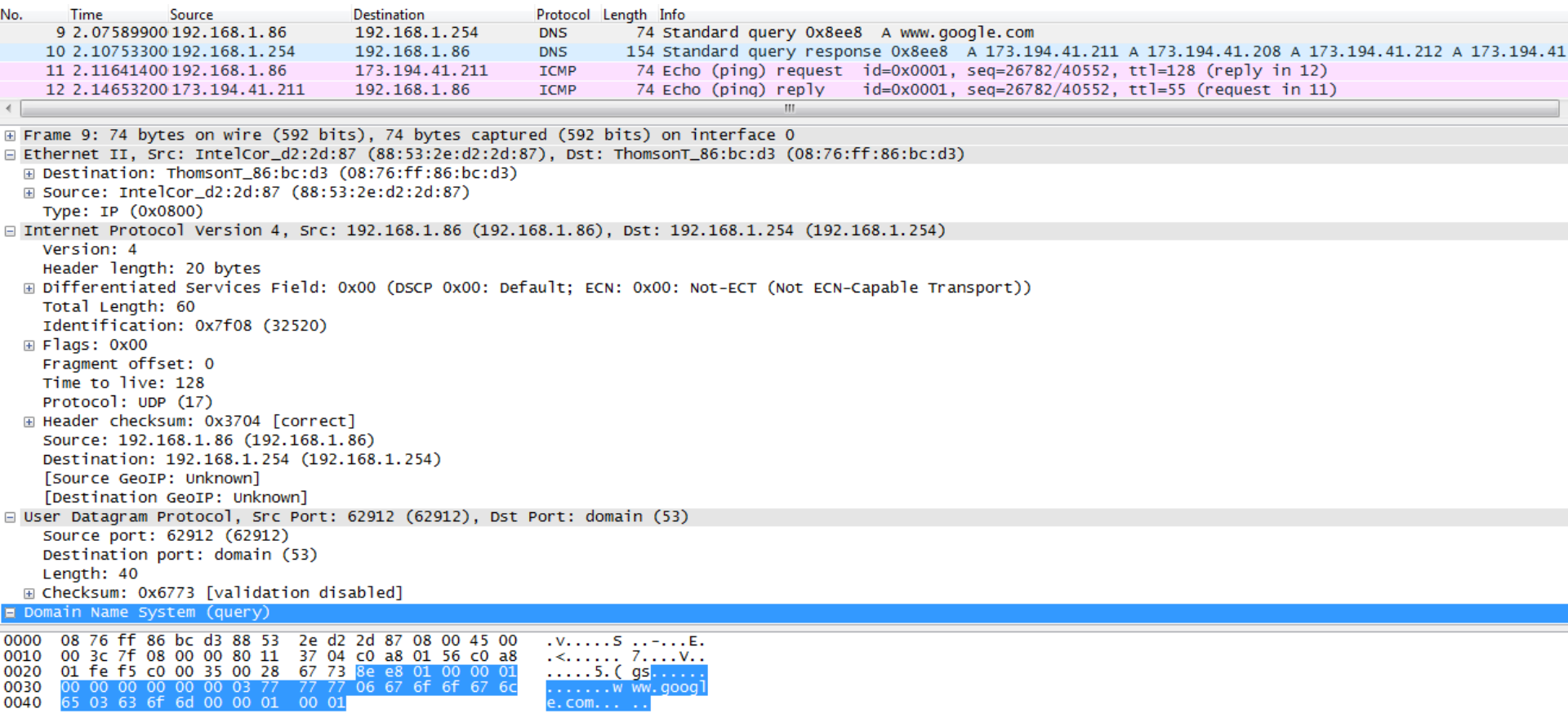
Os protocolos definem o formato e a ordem das mensagens enviadas e recebidas entre as entidades da rede, e as acções executadas quando da transmissão e recepção das mensagens

O que é um protocolo?

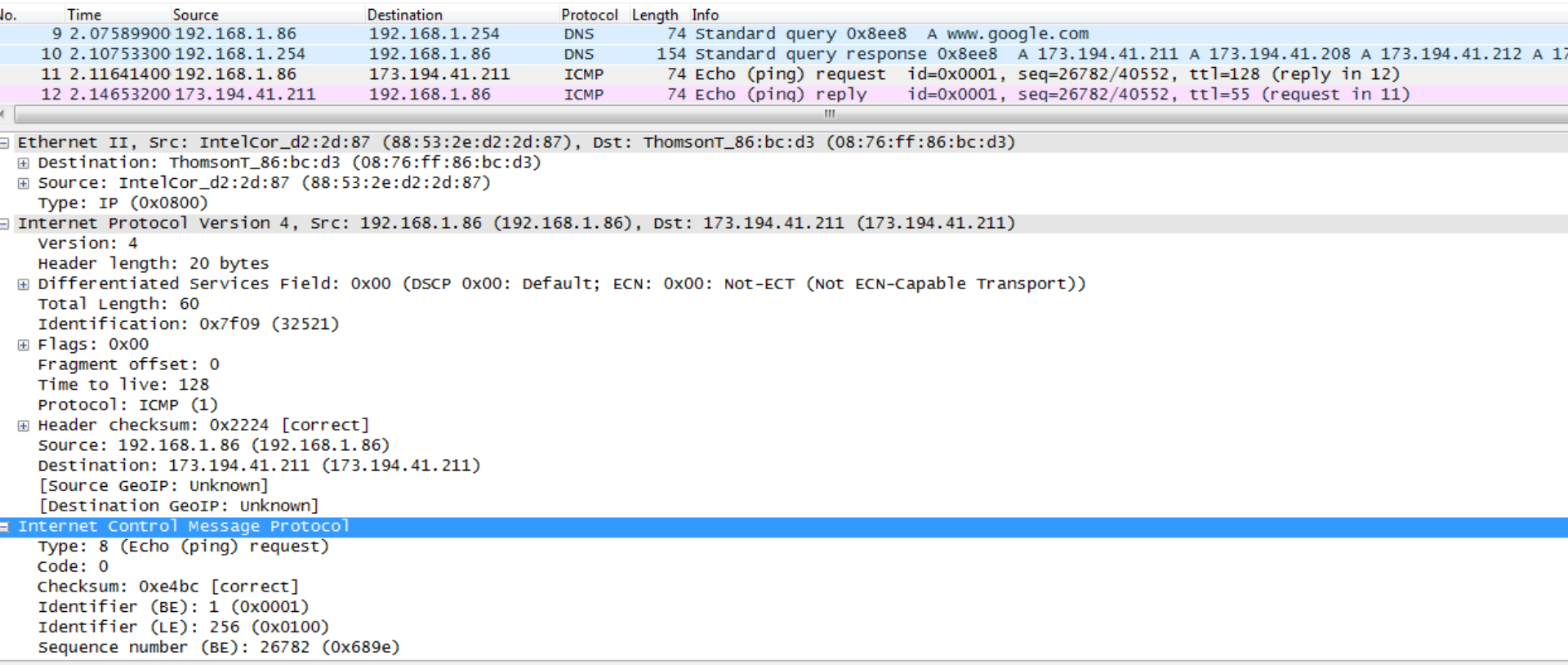
Um protocolo humano e um protocolo de rede:



Pesquisa de endereço google.com



Ping ao google.com



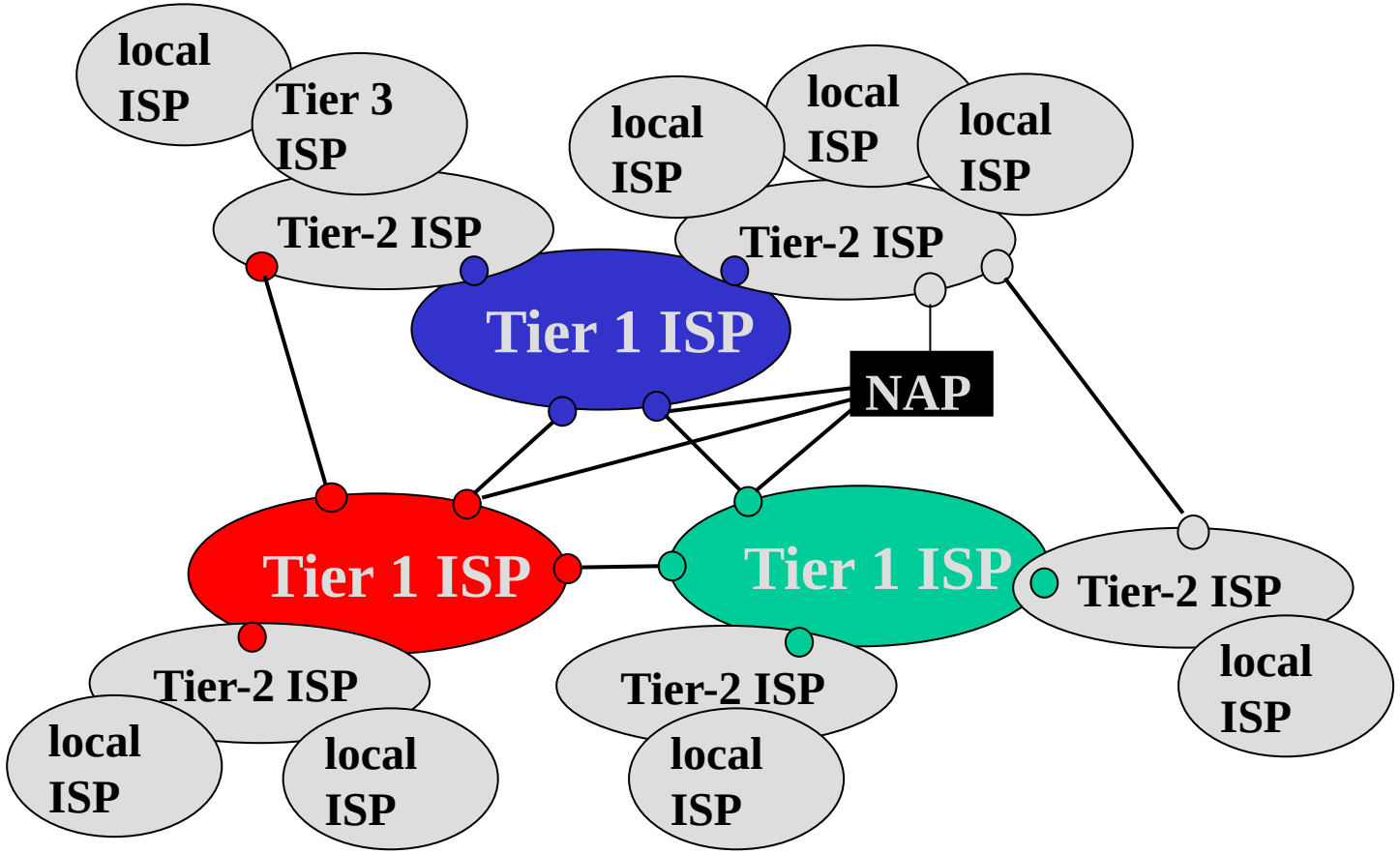
No.	Time	Source	Destination	Protocol	Length	Info
9	2.07589900	192.168.1.86	192.168.1.254	DNS	74	Standard query 0x8ee8 A www.google.com
10	2.10753300	192.168.1.254	192.168.1.86	DNS	154	Standard query response 0x8ee8 A 173.194.41.211 A 173.194.41.208 A 173.194.41.212 A 17
11	2.11641400	192.168.1.86	173.194.41.211	ICMP	74	Echo (ping) request id=0x0001, seq=26782/40552, ttl=128 (reply in 12)
12	2.14653200	173.194.41.211	192.168.1.86	ICMP	74	Echo (ping) reply id=0x0001, seq=26782/40552, ttl=55 (request in 11)

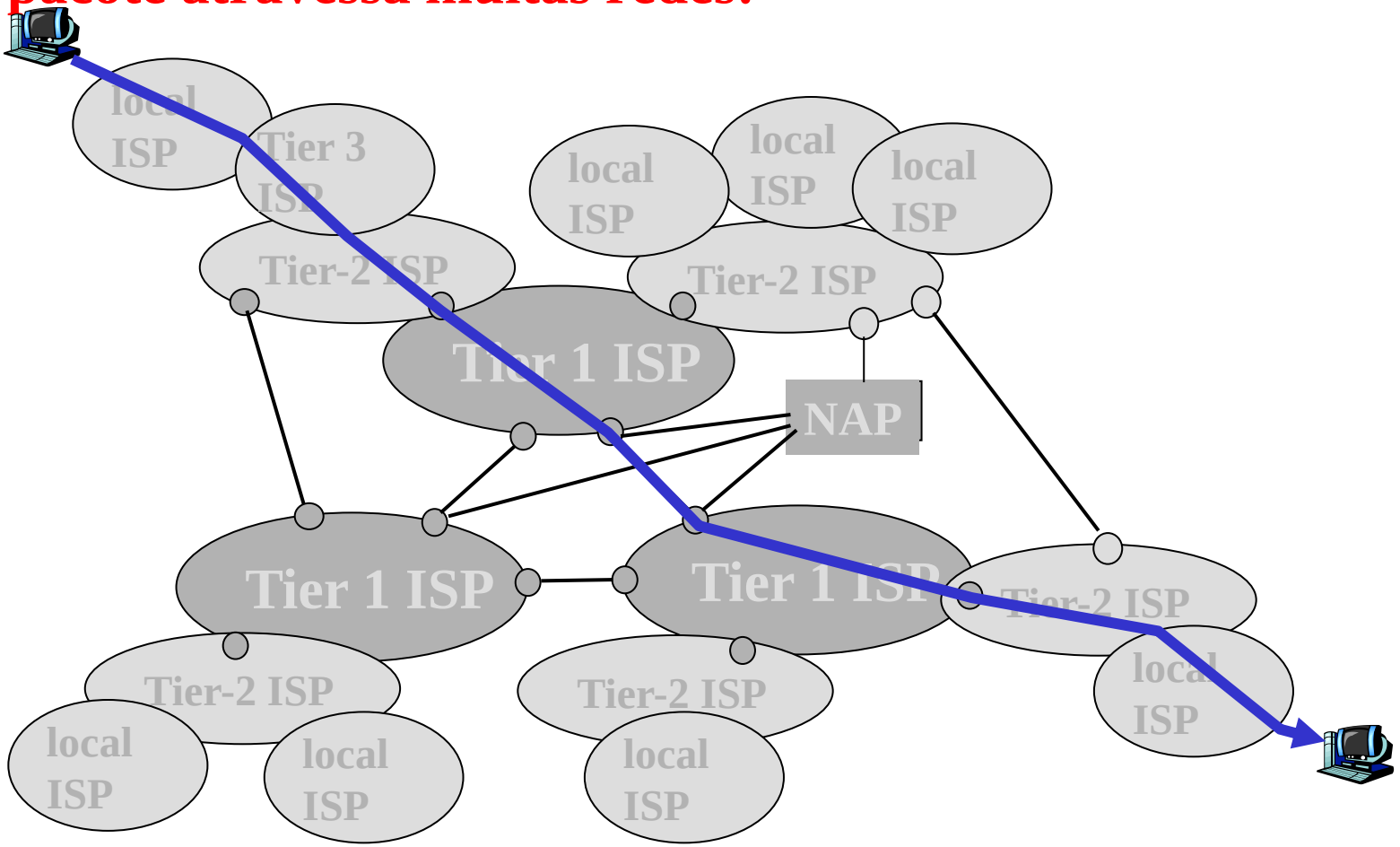
```
Ethernet II, Src: IntelCor_d2:2d:87 (88:53:2e:d2:2d:87), Dst: ThomsonT_86:bc:d3 (08:76:ff:86:bc:d3)
  Destination: ThomsonT_86:bc:d3 (08:76:ff:86:bc:d3)
  Source: IntelCor_d2:2d:87 (88:53:2e:d2:2d:87)
  Type: IP (0x0800)
Internet Protocol Version 4, Src: 192.168.1.86 (192.168.1.86), Dst: 173.194.41.211 (173.194.41.211)
  Version: 4
  Header length: 20 bytes
  Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport))
  Total Length: 60
  Identification: 0x7f09 (32521)
  Flags: 0x00
  Fragment offset: 0
  Time to live: 128
  Protocol: ICMP (1)
  Header checksum: 0x2224 [correct]
  Source: 192.168.1.86 (192.168.1.86)
  Destination: 173.194.41.211 (173.194.41.211)
  [Source GeoIP: Unknown]
  [Destination GeoIP: Unknown]
Internet Control Message Protocol
  Type: 8 (Echo (ping) request)
  Code: 0
  Checksum: 0xe4bc [correct]
  Identifier (BE): 1 (0x0001)
  Identifier (LE): 256 (0x0100)
  Sequence number (BE): 26782 (0x689e)
```

```
0000  08 76 ff 86 bc d3 88 53  2e d2 2d 87 08 00 45 00   .v.....S ..-...E.
0010  00 3c 7f 09 00 00 80 01  22 24 c0 a8 01 56 ad c2   .<...... "$...V..
0020  29 d3 08 00 e4 bc 00 01  68 9e 61 62 63 64 65 66   )....... h.abcdef
0030  67 68 69 6a 6b 6c 6d 6e  6f 70 71 72 73 74 75 76   ghijklmn opqrstuv
0040  77 61 62 63 64 65 66 67  68 69                    wabcdefg hi
```

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!**