



universidade de aveiro
theoria poiesis praxis

Introdução às Redes IP

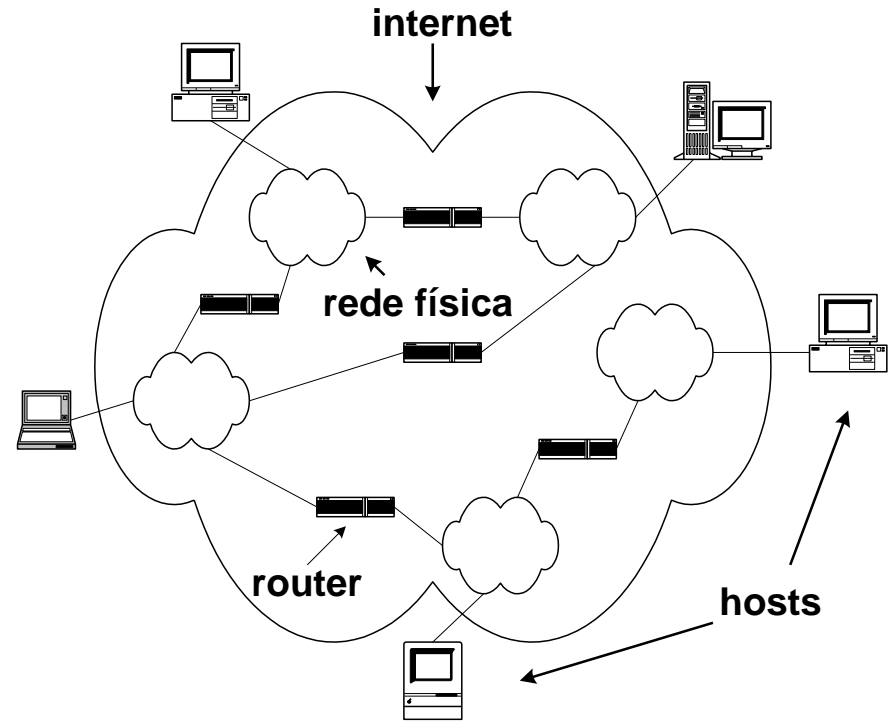
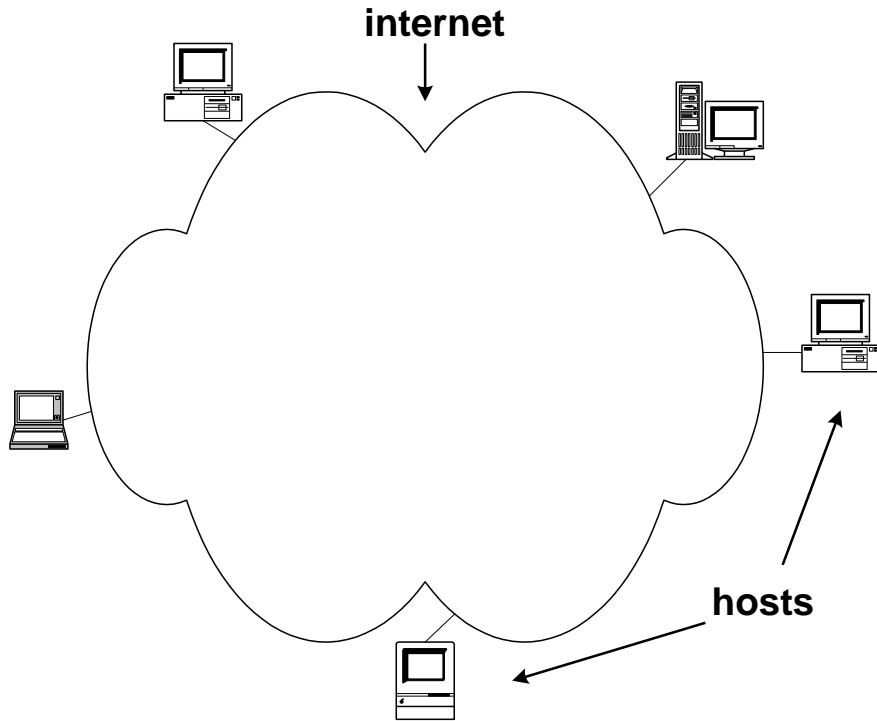
Fundamentos de Redes

**Mestrado Integrado em Engenharia de Computadores e
Telemática**

DETI-UA

2018/2019

A Internet

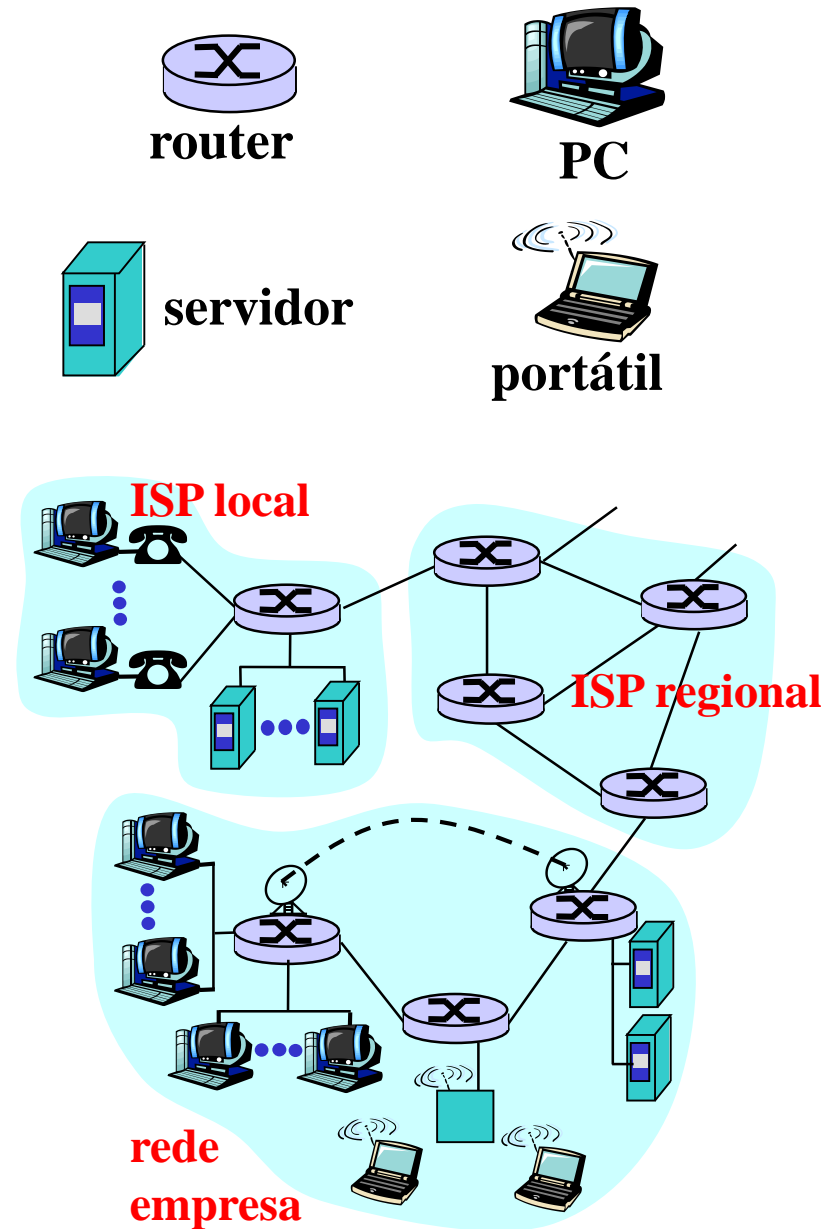


Internet: História

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

O que é a Internet?

- milhões de dispositivos interligados:
hosts ou sistemas terminais
 - PCs, servidores, PDAs, telefones, torradeiras, ...que executam **aplicações distribuídas**
- **ligações físicas**
 - fibra óptica, cobre, rádio, satélite, ...
 - débito de transmissão = **largura de banda**
- **routers**: equipamentos que comutam pacotes entre ligações físicas
- **protocolos** controlam envio e recepção de mensagens
 - e.g., TCP, IP, HTTP, FTP, PPP
- **Internet: “rede de redes”**
 - aproximadamente hierárquica
 - Internet pública versus intranet privada
- **normas Internet**
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



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 [192.168.31.253]
  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.rtl.mad.es.geant.net [62.40.98.107]
  9   111 ms   66 ms   42 ms  xe-2-0-0.mx1.gen.ch.geant.net [62.40.98.107]
 10   49 ms   49 ms   47 ms  ae1.mx1.fra.de.geant.net [62.40.98.107]
 11   49 ms    *   103 ms  xe-8-0-1.edge5.Frankfurt1.Level3.net [4.14.14.1]
 12  193 ms  195 ms  228 ms  vlan60.csw1.Frankfurt1.Level3.net [4.14.14.1]
 13  196 ms  194 ms  257 ms  ae-62-62.ebr2.Frankfurt1.Level3.net [4.14.14.1]
 14  206 ms  249 ms  234 ms  ae-22-22.ebr2.London1.Level3.net [4.14.14.1]
 15  194 ms  229 ms  196 ms  ae-44-44.ebr1.NewYork1.Level3.net [4.14.14.1]
 16  201 ms  196 ms  193 ms  ae-91-91.csw4.NewYork1.Level3.net [4.14.14.1]
 17  197 ms  208 ms  198 ms  ae-92-92.ebr2.NewYork1.Level3.net [4.14.14.1]
 18  196 ms  196 ms  194 ms  ae-2-2.ebr1.SanJose1.Level3.net [4.14.14.1]
 19  195 ms  195 ms  195 ms  ae-81-81.csw3.SanJose1.Level3.net [4.14.14.1]
 20  198 ms  194 ms  194 ms  ae-3-80.edge2.SanJose3.Level3.net [4.14.14.1]
 21    *    201 ms  198 ms  CHINA-TELEC.edge2.SanJose3.Level3.net [4.14.14.1]
 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
```

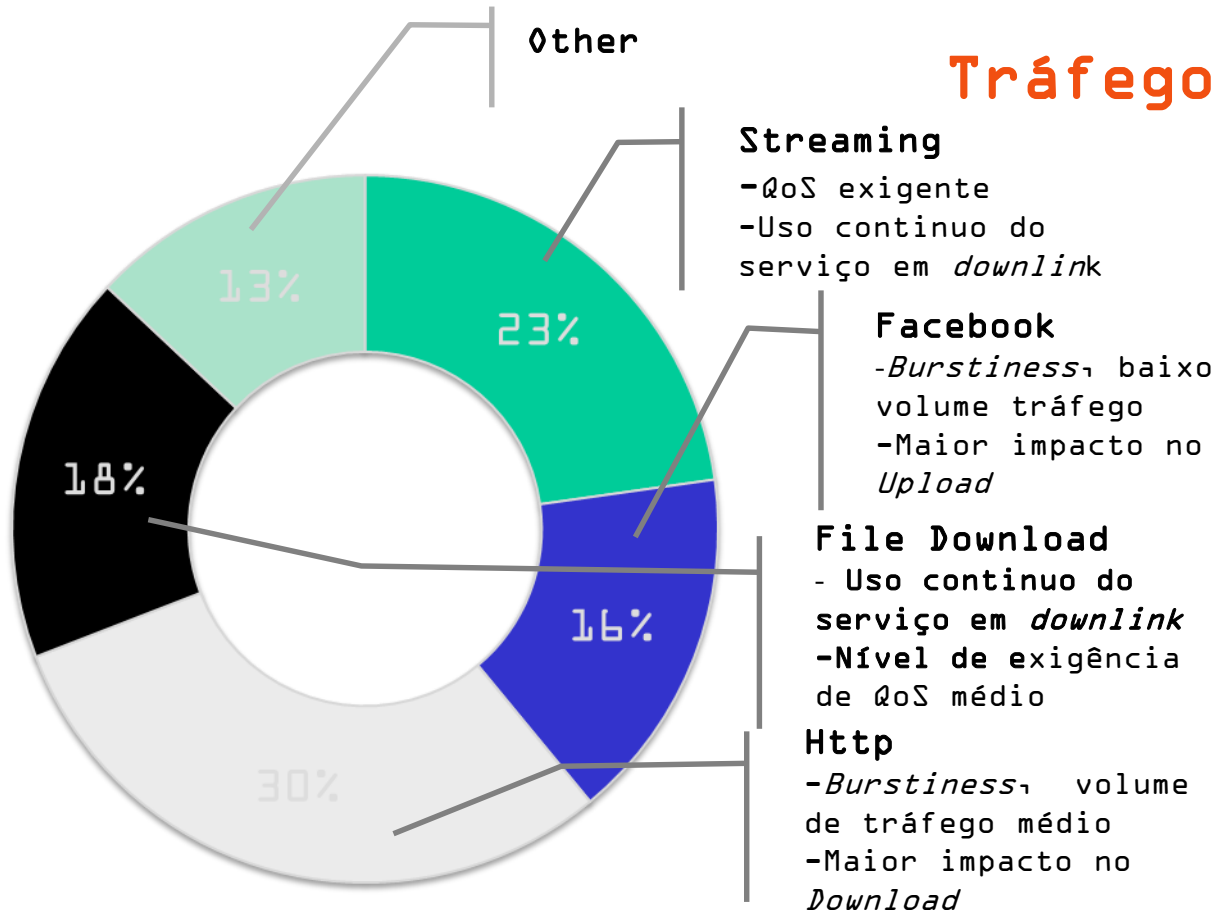
```
Tracing route to online-media.adelaide.edu.au [129.127.144.141]  
over a maximum of 30 hops:
```

```
  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.rtl.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]
 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]
 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]
 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 [202.158.199.141]
 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]
```

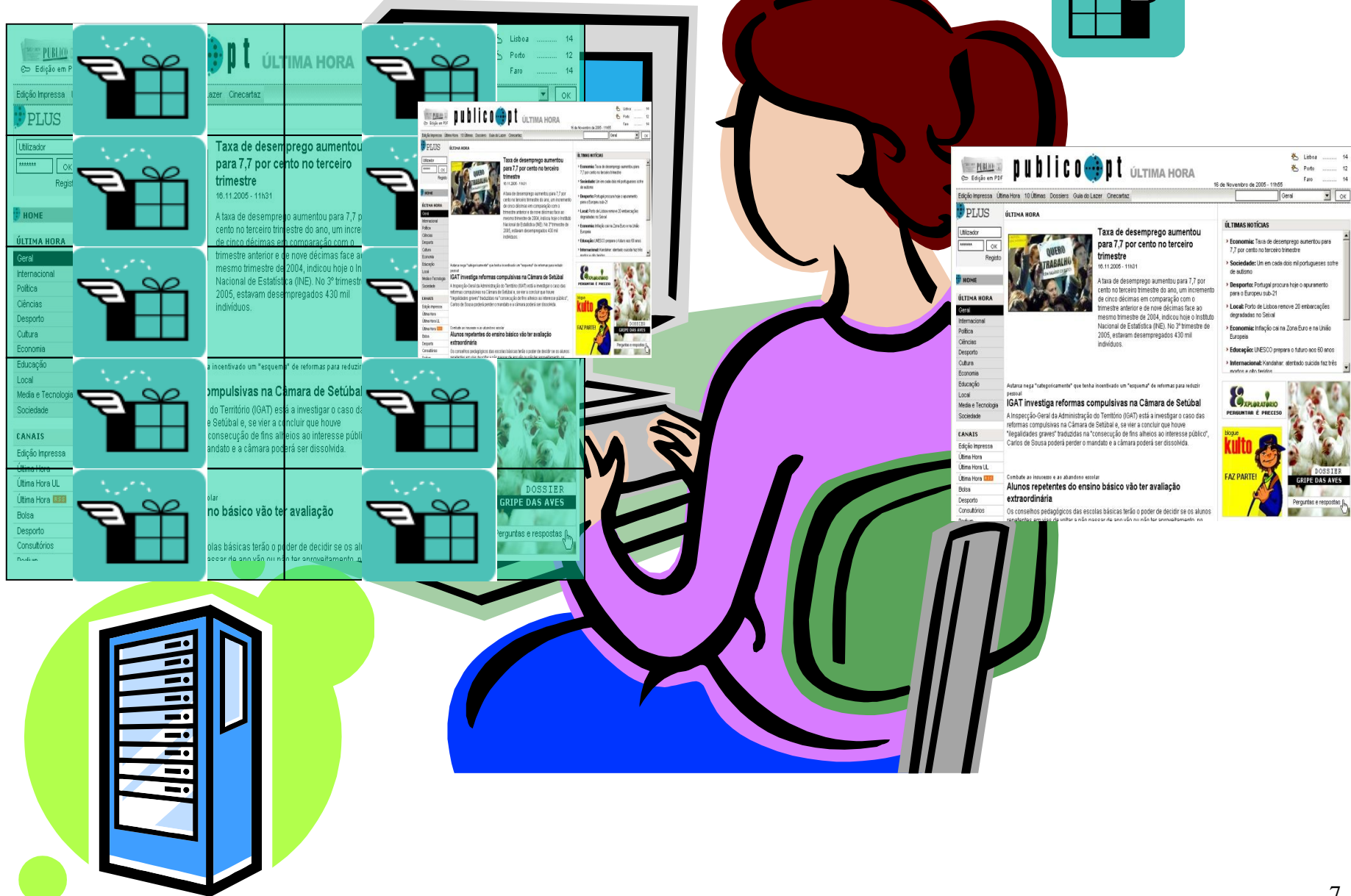
```
Trace complete.
```

Serviços Actuais

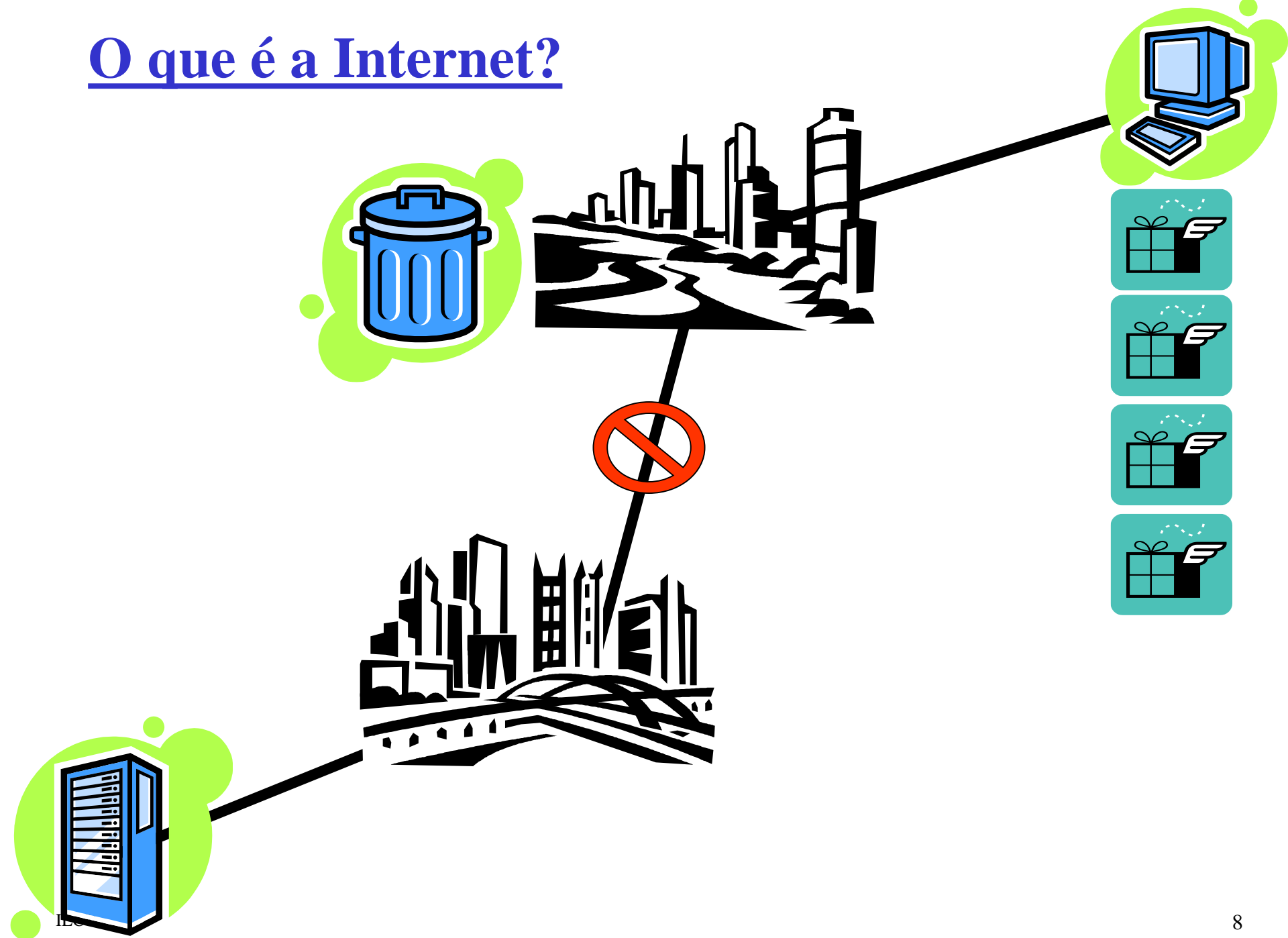
Tráfego 3G- *Smartphone*



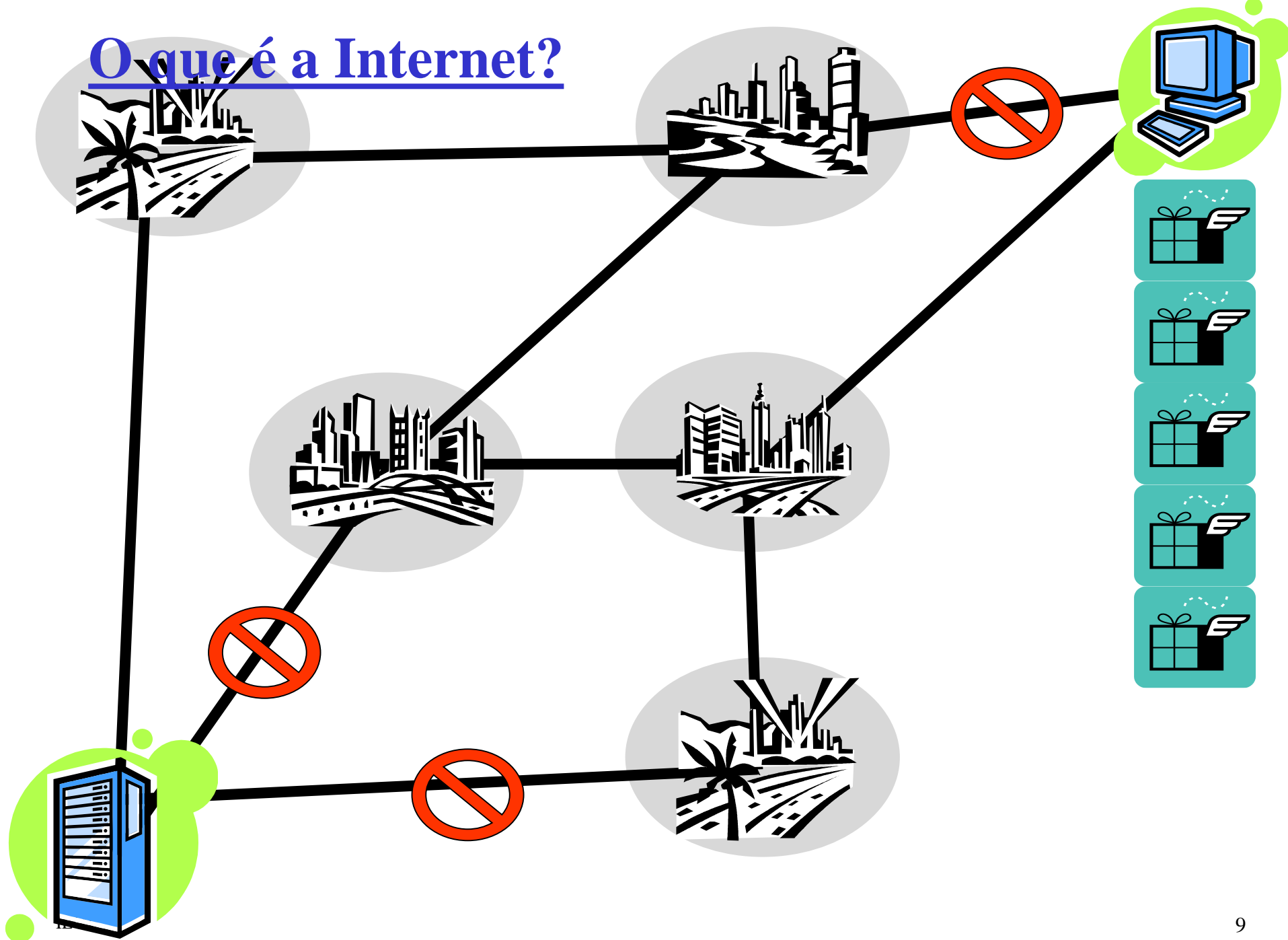
O que é a Internet?



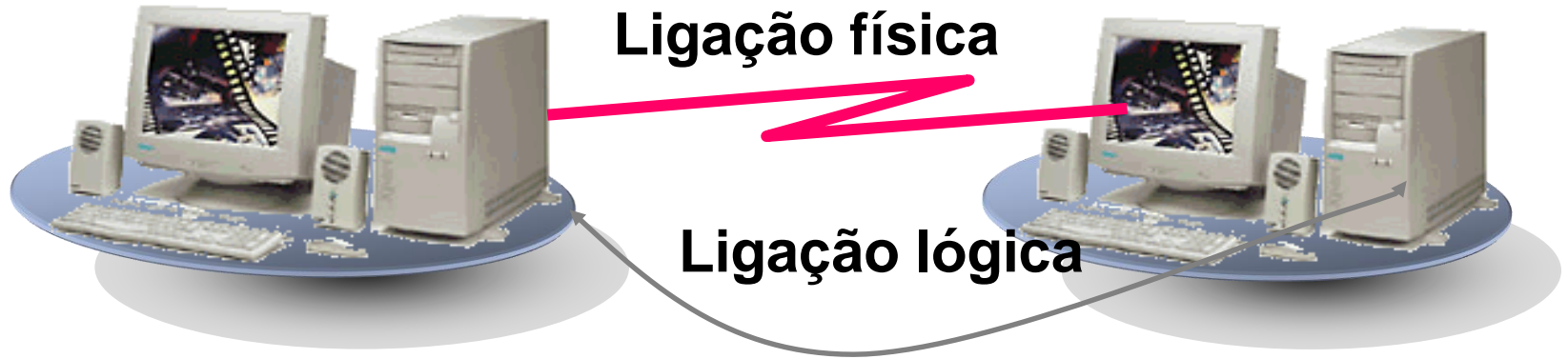
O que é a Internet?



O que é a Internet?



Protocolos



- O estabelecimento de uma ligação lógica entre os equipamentos é função dos protocolos de comunicação
- Estabelecem as normas, procedimentos e interpretações da informação transmitida

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

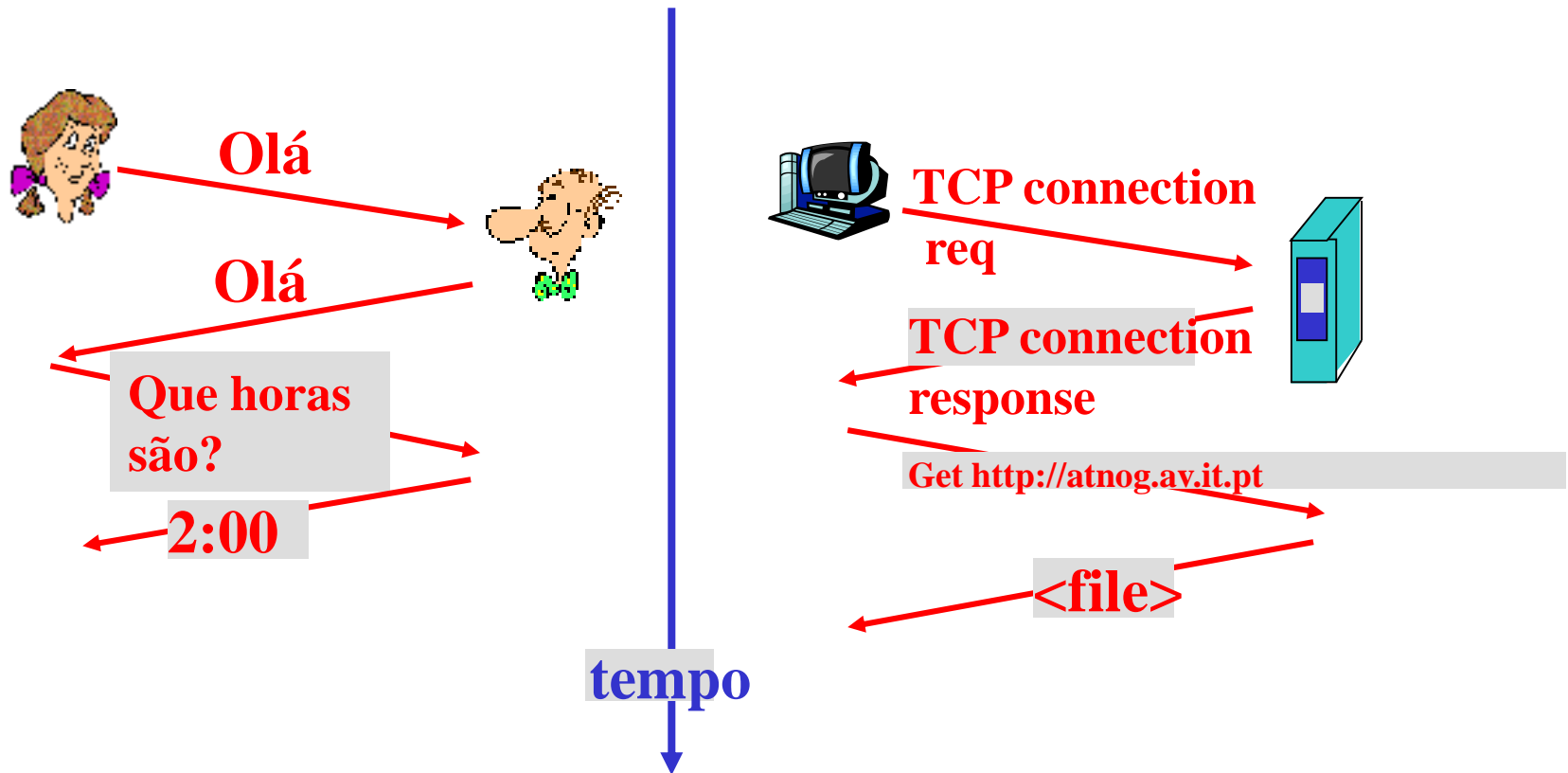
Protocolos de rede:

- Máquinas em vez de humanos
- Todas as comunicações na Internet são executadas 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

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 173.194.41.209
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)

!!!

Frame 9: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0

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: 192.168.1.254 (192.168.1.254)

- 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: 0x7f08 (32520)
- Flags: 0x00
- Fragment offset: 0
- Time to live: 128
- Protocol: UDP (17)
- Header checksum: 0x3704 [correct]
- Source: 192.168.1.86 (192.168.1.86)
- Destination: 192.168.1.254 (192.168.1.254)
- [Source GeoIP: Unknown]
- [Destination GeoIP: Unknown]

User Datagram Protocol, Src Port: 62912 (62912), Dst Port: domain (53)

- Source port: 62912 (62912)
- Destination port: domain (53)
- Length: 40
- Checksum: 0x6773 [validation disabled]

Domain Name System (query)

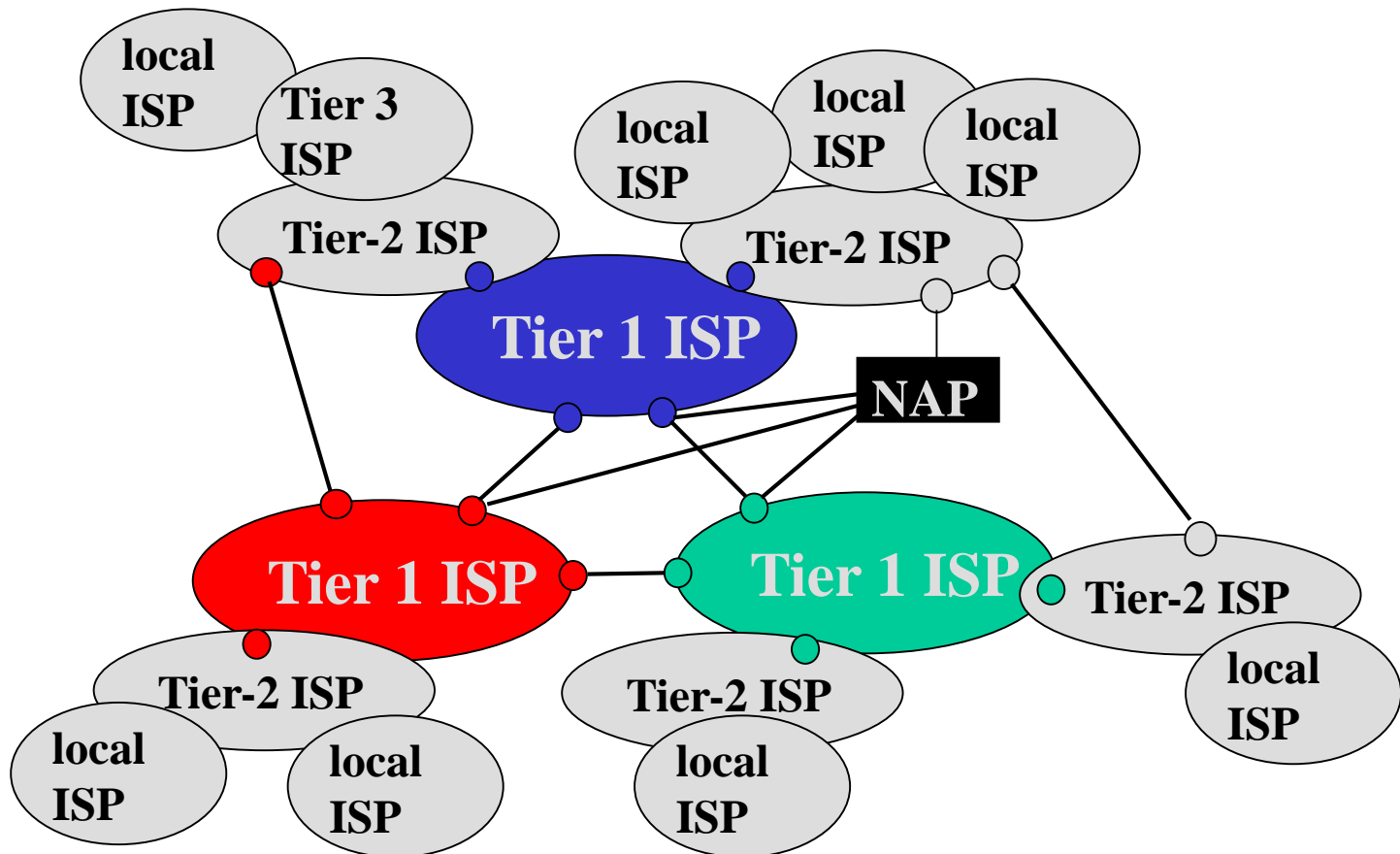
0000	08 76 ff 86 bc d3 88 53 2e d2 2d 87 08 00 45 00	.v.....S ..-...E.
0010	00 3c 7f 08 00 00 80 11 37 04 c0 a8 01 56 c0 a8	.<..... 7...V..
0020	01 fe f5 c0 00 35 00 28 67 73 8e e8 01 00 00 015.(gs.....
0030	00 00 00 00 00 00 03 77 77 77 06 67 6f 6f 67 6cw ww.googl
0040	65 03 63 6f 6d 00 00 01 00 01	e.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 173.194.41.213
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!

