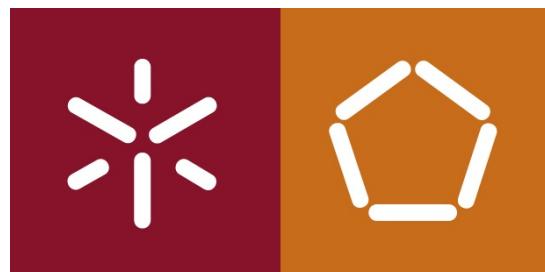


UNIVERSIDADE DO MINHO

Mestrado Integrado em Engenharia Informática



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# REDES DE COMPUTADORES

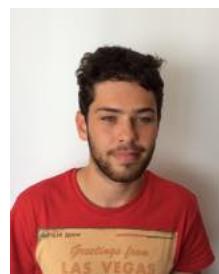
TP4 – Redes Sem Fios (802.11)

Grupo 46

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**1. Identifique em que frequência do espetro está a operar a rede sem fios, e o canal que corresponde a essa frequência.**

A rede sem fios está a operar com frequência igual a 2467MHz, à qual corresponde o canal 12.

No.	Time	Source	Destination	Protocol	Length	Info
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.540874	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
354	14.542494	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2368, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
355	14.643405	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2369, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

```

▶ Frame 346: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)
▶ Radiotap Header v0, Length 25
▼ 802.11 radio information
  PHY type: 802.11g (6)
  Short preamble: False
  Proprietary mode: None (0)
  Data rate: 1.0 Mb/s
  Channel: 12
  Frequency: 2467MHz
  Signal strength (dBm): -66dBm
  Noise level (dBm): -87dBm
  TSF timestamp: 33933542
  ▶ [Duration: 1632us]
  ▶ IEEE 802.11 Beacon frame, Flags: .....
  ▶ IEEE 802.11 wireless LAN

```

**2. Identifique a versão da norma IEEE 802.11 que está a ser usada.**

A versão da norma IEEE 802.11 que está a ser usada é a 802.11g.

No.	Time	Source	Destination	Protocol	Length	Info
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.540874	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
354	14.542494	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2368, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
355	14.643405	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2369, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

```

▶ Frame 346: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)
▶ Radiotap Header v0, Length 25
▼ 802.11 radio information
  PHY type: 802.11g (6)
  Short preamble: False
  Proprietary mode: None (0)
  Data rate: 1.0 Mb/s
  Channel: 12
  Frequency: 2467MHz
  Signal strength (dBm): -66dBm
  Noise level (dBm): -87dBm
  TSF timestamp: 33933542
  ▶ [Duration: 1632us]
  ▶ IEEE 802.11 Beacon frame, Flags: .....
  ▶ IEEE 802.11 wireless LAN

```

**3. Qual o débito a que foi enviada a trama escolhida? Será que esse débito corresponde ao débito máximo a que a interface WiFi pode operar? Justifique.**

A trama 346 foi enviada a um débito de 1Mb/s, sendo inferior ao débito máximo a que a interface WiFi pode operar – 54 Mb/s.

No.	Time	Source	Destination	Protocol	Length	Info
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.130329	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.540874	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
354	14.542494	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2368, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
355	14.643405	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2369, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

4. Selecione a trama beacon 346. Esta trama pertence a que tipo de tramas 802.11? Indique o valor dos seus identificadores de tipo e de subtipo. Em que parte concreta do cabeçalho da trama estão especificados?  
A trama em questão é uma trama de gestão. O tipo é identificado pelo valor 0 e o subtipo por 8, no byte 25 do cabeçalho da trama, no campo Frame Control.

No.	Time	Source	Destination	Protocol	Length	Info
342	13.928225	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.504074	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
354	14.542494	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2368, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
355	14.643405	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2369, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
► 802.11 radio information						
▼ IEEE 802.11 Beacon frame, Flags: .....C						
Type/Subtype: Beacon frame (0x00008)						
▼ Frame Control Field: 0x0000						
.... .00 = Version: 0						
.... 00.. = Type: Management frame (0)						
1000 .... = Subtype: 8						
Flags: 0x00						
.0000 0000 0000 0000 = Duration: 0 microseconds						
Receiver address: Broadcast (ffff:ffff:ff:ff:ff:ff)						
Destination address: Broadcast (ffff:ffff:ff:ff:ff:ff)						
Transmitter address: HironTe_af:b1:99 (bc:14:01:af:b1:99)						
Source address: HironTe_af:b1:99 (bc:14:01:af:b1:99)						
BSS Id: HironTe_af:b1:99 (bc:14:01:af:b1:99)						
.... .... 0000 = Fragment number: 0						
1001 0011 1000 .... = Sequence number: 2360						
Frame check sequence: 0x14146099 [correct]						
[FCS Status: Good]						
0000	00 00 19 00 6f 08 00 00	e6 c8 05 02 00 00 00 00	.....0 .....	.....	.....	.....
0010	10 02 a3 09 80 04 be a9	00 80 00 00 ff ff ff	.....	.....	.....	.....
0020	ff ff ff bc 14 01 af b1	99 bc 14 01 af b1 99 80	.....	.....	.....	.....
0030	93 3d eb 8c ae 0b 01 00	00 64 00 21 0c 00 0c 4e	=.....	d ! ..	N	.....
0040	4f 53 5f 57 49 46 49 5f	46 6f 6e 01 08 82 84 Bb	0S_WIFI_	Fon	.....	.....
0050	96 12 24 48 6c 03 01 0c	32 04 8c 98 b6 60 05 05	.....SHL ..	2 ..	.....	.....
0060	01 03 00 4a 01 2a 01 00	2d 1a 8c 01 16 ff ff 00	.....J *	- ..	.....	.....
0070	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....	.....	.....	.....
0080	00 00 00 00 3d 16 0c 00	04 00 00 00 00 00 00 00	.....	.....	.....	.....
0090	00 00 00 00 00 00 00 00	00 00 00 00 7f 01 01 dd	.....	.....	.....	.....
00a0	18 00 50 f2 02 01 80 00	03 a4 00 00 27 a4 00	.....P ..	..	.....	.....
00b0	00 42 43 5e 00 62 32 2f	00 00 05 03 00 0a 12 7a	.....BC^ b2/ ..	z	.....	.....
00c0	dd 07 00 0c 43 00 00 00	00 95 60 14 14	.....C ..	.....	.....	.....

5. Liste todos os SSIDs dos APs que estão a operar na vizinhança da STA de captura. Explicite o modo como obteve essa informação. Como sugestão pode construir um filtro de visualização apropriado que lhe permita obter a listagem pretendida.

Para obter o resultado apresentado na captura de ecrã, aplicamos o filtro “wlan.fc.type\_subtype==0x08”, que faz com que apenas sejam apresentadas as tramas beacon, tendo também ordenado as tramas por ordem alfabética das fontes das tramas, para assim conseguir analisar os SSIDs dos APs existentes. Como é possível ver na figura que se segue, existem dois APs a operar na vizinhança da STA, com os SSIDs FlyingNet e NOS\_WIFI\_Fon.

wlan.fc.type_subtype == 0x0008						
No.	Time	Source	Destination	Protocol	Length	Info
161...	112.640488	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=187, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	112.742974	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=189, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	112.845285	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=191, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	112.947562	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=193, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.049990	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=195, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.152549	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=197, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.254896	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=199, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.357242	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=201, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.459632	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=203, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.561990	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=205, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
161...	113.664497	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=207, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
► Frame 16103: 296 bytes on wire (2368 bits), 296 bytes captured (2368 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
► IEEE 802.11 Beacon frame, Flags: .....						
► IEEE 802.11 wireless LAN						
▼ Fixed parameters (12 bytes)						
Timestamp: 0x0000010bb46c01f7						
Beacon Interval: 0.102400 [Seconds]						
► Capabilities Information: 0x0c31						
► Tagged parameters (231 bytes)						
► Frame 280: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
► IEEE 802.11 Beacon frame, Flags: .....						
► IEEE 802.11 wireless LAN						
▼ Fixed parameters (12 bytes)						
Timestamp: 0x0000010bae57cb19						
Beacon Interval: 0.102400 [Seconds]						
► Capabilities Information: 0x0c21						
► Tagged parameters (140 bytes)						

wlan.fc.type_subtype == 0x0008						
No.	Time	Source	Destination	Protocol	Length	Info
274	10.344112	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2286, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
276	10.446507	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2288, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
278	10.548833	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2290, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
280	10.651246	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2292, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
282	10.753667	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2294, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
284	10.856059	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2296, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
286	10.958458	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2298, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
288	11.060824	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2300, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
290	11.163258	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2302, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
293	11.368126	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2306, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
295	11.470471	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2308, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
► Frame 280: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
► IEEE 802.11 Beacon frame, Flags: .....						
► IEEE 802.11 wireless LAN						
▼ Fixed parameters (12 bytes)						
Timestamp: 0x0000010bae57cb19						
Beacon Interval: 0.102400 [Seconds]						
► Capabilities Information: 0x0c21						
► Tagged parameters (140 bytes)						

- Verifique se está a ser usado o método de deteção de erros (CRC), e se todas as tramas Beacon são recebidas corretamente. Justifique o porquê de usar deteção de erros neste tipo de locais.

Verificamos nas imagens seguintes que está presente o campo Frame Check Sequence, que no primeiro caso nos indica que a trama foi recebida corretamente, enquanto que no segundo caso indica que o valor está incorreto e apresenta aquele que deveria ser o valor do campo.

Neste tipo de redes, a ocorrência de colisões e erros nas tramas é muito superior a outras, como por exemplo a Ethernet. Logo, é necessário usar um método que permita detetar erros.

No.	Time	Source	Destination	Protocol	Length	Info
338	13.723430	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2352, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
339	13.824206	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2353, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
340	13.825838	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2354, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
341	13.926596	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2355, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
► Frame 346: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
► IEEE 802.11 Beacon frame, Flags: .....C						
Type/Subtype: Beacon frame (0x0008)						
► Frame Control Field: 0x8000						
.000 0000 0000 0000 = Duration: 0 microseconds						
Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)						
Destination address: Broadcast (ff:ffff:ffff:ffff:ff:ff)						
Transmitter address: HitronTe_af:b1:99 (bc:14:01:af:b1:99)						
Source address: HitronTe_af:b1:99 (bc:14:01:af:b1:99)						
BSS Id: HitronTe_af:b1:99 (bc:14:01:af:b1:99)						
.... .... .... 0000 = Fragment number: 0						
1001 0011 1000 .... = Sequence number: 2360						
Frame check sequence: 0x14146099 [correct]						
[FCS Status: Good]						
► IEEE 802.11 wireless LAN						
0000 00 00 19 00 6f 08 00 00 e6 c8 05 02 00 00 00 00 .....						
0010 10 02 a3 09 80 04 be a9 00 80 00 00 00 ff ff ff .....						
0020 ff ff ff bc 14 01 af b1 99 bc 14 01 af b1 99 80 .....						
0030 93 3d eb 8c ae 0b 01 00 00 64 00 21 0c 00 0c 4e  =..... d ! .. N						
0040 4f 53 5f 57 49 46 49 5f 46 6f 6e 01 08 82 84 8b OS_WIFI_Fon ..						
0050 96 12 24 48 6c 03 01 0c 32 04 8c 98 b0 60 05 05 ..SHL .. 2 ..						
0060 01 03 00 04 01 2a 01 00 2d 1a 8c 01 16 ff ff 00 ..J * .. - ..						
0070 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .. - ..						
0080 00 00 00 00 3d 16 0c 00 04 00 00 00 00 00 00 00 ..= ..						
0090 00 00 00 00 00 00 00 00 00 00 00 00 7f 01 01 dd ..						
00a0 18 00 50 f2 01 01 80 00 03 a4 00 00 27 a4 00 ..P .. - ..						
00b0 00 42 43 5e 00 62 32 2f 00 0b 05 03 00 0a 12 7a BC^ b2/ ..z ..						
00c0 dd 07 00 0c 43 00 00 00 00 99 00 14 14 ..C ..` ..						

No.	Time	Source	Destination	Protocol	Length	Info
413	17.715376	HitronTe_af:b1:99	Broadcast	802.11	296	Beacon frame, SN=2429, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
414	17.717009	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2430, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
415	17.717751	Apple_28:b8:0c	HitronTe_af:b1:99	802.11	49	Null function (No data), SN=0, FN=0, Flags=.....T
416	17.717784	Apple_28:b8:0c	(68..)	802.11	39	Acknowledgement, Flags=.....C
417	17.717878	HitronTe_af:b1:98 ..	Apple_28:b8:0c (68..)	802.11	49	802.11 Block Ack Req, Flags=.....C
418	17.718278	HitronTe_af:b1:98	Apple_28:b8:0c	802.11	226	QoS Data, SN=14, FN=0, Flags=.p...F..
419	17.720732	Apple_28:b8:0c	HitronTe_af:b1:98	802.11	166	QoS Data, SN=26, FN=0, Flags=.p...T
420	17.720762		Apple_28:b8:0c (68..)	802.11	39	Acknowledgement, Flags=.....C
421	17.817787	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2431, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
422	17.819437	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2432, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
423	17.920179	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2433, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
► Frame 418: 226 bytes on wire (1808 bits), 226 bytes captured (1808 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
► IEEE 802.11 QoS Data, Flags: .p...F..						
Type/Subtype: QoS Data (0x0028)						
► Frame Control Field: 0x8842						
.000 0000 0100 = Duration: 36 microseconds						
Receiver address: Apple_28:b8:0c (68:a8:6d:28:b8:0c)						
Destination address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
BSS Id: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
.... .... .... 0000 = Fragment number: 0						
0000 0000 1110 .... = Sequence number: 14						
Frame check sequence: 0x877d9204 incorrect, should be 0x16cc7220						
[FCS Status: Bad]						
► QoS Control: 0x0000						
► CCMP parameters						
► Data (163 bytes)						

7. Para dois dos APs identificados, indique qual é o intervalo de tempo previsto entre tramas beacon consecutivas? Na prática, a periodicidade de tramas beacon é verificada? Porquê?

Para os dois APs identificados, o intervalo de tempo previsto é de 0,102400 segundos. Na prática, a periodicidade observada, por exemplo, entre a trama 346 e 347 é de 0,100975 segundos, sendo um valor muito próximo do previsto.

No.	Time	Source	Destination	Protocol	Length	Info
340	13.825838	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2354, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
341	13.926596	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2355, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
342	13.928225	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HironTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HironTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.540074	HironTe_af:b1:00	Broadcast	802.11	206	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
.... .00 = Version 0 .... .00.. = Type: Management frame (0) 1000 .... = Subtype: 8 ► Flags: 0x00 .0000 0000 0000 0000 = Duration: 0 microseconds Receiver address: Broadcast (ff:ffff:ffff:ffff:ffff) Destination address: Broadcast (ffff:ffff:ffff:ffff:ffff) Transmitter address: HironTe_af:b1:99 (bc:14:01:af:b1:99) Source address: HironTe_af:b1:99 (bc:14:01:af:b1:99) BSS Id: HironTe_af:b1:99 (bc:14:01:af:b1:99) .... .0000 = Fragment number: 0 1001 0011 1000 .... = Sequence number: 2360 Frame check sequence: 0x14146099 [correct] [FCS Status: Good]						
▼ IEEE 802.11 wireless LAN ▼ Fixed parameters (12 bytes) Timestamp: 0x0000010bae8ceb3d Beacon Interval: 0.102400 [Seconds] ▼ Capabilities Information: 0x0c21 .... .... .... ..1 = ESS capabilities: Transmitter is an AP .... .... .... ..0.. = IBSS status: Transmitter belongs to a BSS .... ..0. .... 00.. = CFP participation capabilities: No point coordinator at AP (0x00) .... .... ..0 .... = Privacy: AP/STA cannot support WEP .... .... ..1 .... = Short Preamble: Allowed .... ..0.. .... = PBC: Not Allowed						
0030	93 3d eb 8c ae 0b 01 00 00 64 00 21 0c 00 0c 4e	=.....:d1!-N				
0040	4f 53 5f 57 49 46 49 5f	46 6f 6e 01 08 82 84 8b	05_WIFI_Fon			
0050	96 12 24 48 6c 03 01 0c	32 04 8c 98 b6 05 05	....SH1..-2-`-			
0060	01 03 00 4a 01 2a 01 00	32 1a 8c 01 16 ff ff 00	....J-*..-.....			
0070	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	....-.....			
0080	00 00 00 00 3d 16 0c 00	04 00 00 00 00 00 00 00	....-.....			
.... .00 = Version 0 .... .00.. = Type: Management frame (0) 1000 .... = Subtype: 8 ► Flags: 0x00 .0000 0000 0000 0000 = Duration: 0 microseconds Receiver address: Broadcast (ff:ffff:ffff:ffff:ffff) Destination address: Broadcast (ffff:ffff:ffff:ffff:ffff) Transmitter address: HironTe_af:b1:98 (bc:14:01:af:b1:98) Source address: HironTe_af:b1:98 (bc:14:01:af:b1:98) BSS Id: HironTe_af:b1:98 (bc:14:01:af:b1:98) .... .0000 = Fragment number: 0 1001 0011 1001 .... = Sequence number: 2361 Frame check sequence: 0x55a094da [correct] [FCS Status: Good]						
▼ IEEE 802.11 wireless LAN ▼ Fixed parameters (12 bytes) Timestamp: 0x0000010bae871fa Beacon Interval: 0.102400 [Seconds] ▼ Capabilities Information: 0x0c31 .... .... .... ..1 = ESS capabilities: Transmitter is an AP .... .... .... ..0.. = IBSS status: Transmitter belongs to a BSS .... ..0. .... 00.. = CFP participation capabilities: No point coordinator at AP (0x00) .... .... ..1 .... = Privacy: AP/STA can support WEP .... .... ..1 .... = Short Preamble: Allowed .... ..0.. .... = PBC: Not Allowed						
0030	93 fa 71 8e ae 0b 01 00 00 64 00 31 0c 00 09 46	-q....:d1-F				
0040	6c 79 69 6e 67 4e 65 74	01 08 82 84 8b 96 12 24	lyingNet .....\$			
0050	48 6c 03 01 0c 32 04 8c	98 b6 05 dd 27 00 50 f2	H1...2-..			
0060	04 10 4a 00 01 10 10 44	00 01 02 10 47 00 10 28	..J...D ...G-(			
0070	80 28 80 28 80 18 80 88	00 bc 14 af b1 98 10	.(.-. ....			
0080	3c 00 01 05 04 00 03	00 50 2a 01 00 2d 1a 8c	<.....:P*-....			

## 8. Identifique e registe todos os endereços MAC usados nas tramas beacon enviadas pelos APs.

No.	Time	Source	Destination	Protocol	Length	Info
340	13.825838	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2354, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
341	13.926596	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2355, FN=0, Flags=....., BI=100, SSID=FlyingNet
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=....., BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=....., BI=100, SSID=FlyingNet
346	14.133829	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=....., BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=....., BI=100, SSID=FlyingNet
350	14.337754	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=....., BI=100, SSID=FlyingNet
352	14.440234	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
353	14.540874	HitronTe_af:b1:00	Broadcast	802.11	206	Beacon frame, SN=2367, FN=0, Flags=....., BI=100, SSID=FlyingNet

► Frame 346: 205 bytes on wire (1640 bits), 205 bytes captured (1640 bits)

► Radiotap Header v0, Length 25

► 802.11 radio information

▼ IEEE 802.11 Beacon frame, Flags: .....

Type/Subtype: Beacon frame (0x0008)

Frame Control Field: 0x0000

.... .00 = Version: 0

.... 00.. = Type: Management frame (0)

1000 .... = Subtype: 8

> Flags: 0x00

.000 0000 0000 0000 = Duration: 0 microseconds

Receiver address: Broadcast (ffff:ffff:ffff:ffff)

Transmitter address: HitronTe\_af:b1:99 (bc:14:01:af:b1:99)

Source address: HitronTe\_af:b1:99 (bc:14:01:af:b1:99)

BSS Id: HitronTe\_af:b1:99 (bc:14:01:af:b1:99)

.... .... 0000 = Fragment number: 0

1001 0011 1000 .... = Sequence number: 2360

Frame check sequence: 0x14146099 [correct]

[FCS Status: Good]

► IEEE 802.11 wireless LAN

0010	10 02 a3 09 80 04	be a9	00 80 00 00 00 ff ff ff	.....	.....	.....
0020	ff ff ff bc 14 01 af b1	99 bc 14 01 af b1 99 80	.....	.....	.....	.....
0030	93 3d eb 8e ae 0b 01 00	00 64 00 21 0c 00 0c 4e	:=..... d ! - N	.....	.....	.....
0040	4f 53 4f 57 49 46 49 5f	46 6f 6e 01 08 82 94 88	05_WIFI_ Fon	.....	.....	.....
0050	96 12 24 48 6c 03 01 03	32 04 8c 98 b6 00 05 05	:SH! - 2 -	.....	.....	.....
0060	01 03 00 4a 01 2a 01 00	2d 1a 8c 01 16 ff ff 00	...J-* - - -	.....	.....	.....

No.	Time	Source	Destination	Protocol	Length	Info
340	13.825838	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2354, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
341	13.926596	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2355, FN=0, Flags=....., BI=100, SSID=FlyingNet
342	13.928225	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=....., BI=100, SSID=FlyingNet
344	14.030499	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=....., BI=100, SSID=FlyingNet
346	14.133829	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=....., BI=100, SSID=FlyingNet
348	14.235456	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=....., BI=100, SSID=FlyingNet
350	14.337754	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=....., BI=100, SSID=FlyingNet
352	14.440234	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=....., BI=100, SSID=NOS_WIFI_Fon
353	14.540874	HitronTe_af:b1:00	Broadcast	802.11	206	Beacon frame, SN=2367, FN=0, Flags=....., BI=100, SSID=FlyingNet

► Frame 347: 296 bytes on wire (2368 bits), 296 bytes captured (2368 bits)

► Radiotap Header v0, Length 25

► 802.11 radio information

▼ IEEE 802.11 Beacon frame, Flags: .....

Type/Subtype: Beacon frame (0x0008)

Frame Control Field: 0x0000

.... .00 = Version: 0

.... 00.. = Type: Management frame (0)

1000 .... = Subtype: 8

> Flags: 0x00

.000 0000 0000 0000 = Duration: 0 microseconds

Receiver address: Broadcast (ffff:ffff:ffff:ffff)

Transmitter address: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)

Source address: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)

BSS Id: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)

.... .... 0000 = Fragment number: 0

1001 0011 1001 .... = Sequence number: 2361

Frame check sequence: 0x55a094da [correct]

[FCS Status: Good]

► IEEE 802.11 wireless LAN

0010	10 02 a3 09 80 04	c4 a9	00 80 00 00 00 ff ff ff	.....	.....	.....
0020	ff ff ff bc 14 01 af b1	98 bc 14 01 af b1 98 80	.....	.....	.....	.....
0030	93 fa 71 8e ae 0b 01 00	00 64 00 31 0c 00 09 46	:q..... d 1 - F	.....	.....	.....
0040	6c 79 69 6e 67 4e 65 74	01 08 82 84 8b 96 12 24	lyingNet ..... \$	.....	.....	.....
0050	48 6c 03 01 02 32 04 8c	98 b6 00 dd 27 00 50 f2	Hl - 2 - .P	.....	.....	.....
0060	04 10 4a 00 01 10 44	00 01 02 10 47 00 10 28	-J--D - G - (	.....	.....	.....

- As tramas beacon anunciam que o AP pode suportar vários débitos de base assim como vários “extended supported rates”. Indique quais são esses débitos. O AP com SSID NOS\_WIFI\_Fon pode suportar débitos de base de 1 até 54Mbps e “extended supported Rates” de 6 até 48Mbps:

No.	Time	Source	Destination	Protocol	Length	Info
340	13.825838	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2354, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
341	13.926596	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2355, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
342	13.928225	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2356, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
343	14.028868	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2357, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
344	14.030499	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2358, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
345	14.131398	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2359, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
346	14.133029	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2360, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
347	14.233824	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2361, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
348	14.235456	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2362, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
349	14.336138	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2363, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
350	14.337754	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2364, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
351	14.438603	HitonTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2365, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
352	14.440234	HitonTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2366, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
353	14.540074	HitonTe_af:b1:98	Broadcast	802.11	206	Beacon frame, SN=2367, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
0... .... .... .... = Immediate Block Ack: Not Implemented						
▼ Tagged parameters (140 bytes)						
► Tag: SSID parameter set: NOS_WIFI_Fon						
► Tag: Supported Rates 1(B), 2(B), 5.5(B), 11(B), 9, 18, 36, 54, [Mbit/sec]						
Tag Number: Supported Rates (1)						
Tag length: 8						
Supported Rates: 1(B) (0x82)						
Supported Rates: 2(B) (0x84)						
Supported Rates: 5.5(B) (0x8b)						
Supported Rates: 11(B) (0x96)						
Supported Rates: 9 (0x12)						
Supported Rates: 18 (0x24)						
Supported Rates: 36 (0x48)						
Supported Rates: 54 (0x6c)						
► Tag: DS Parameter set: Current Channel: 12						
► Tag: Extended Supported Rates 6(B), 12(B), 24(B), 48, [Mbit/sec]						
Tag Number: Extended Supported Rates (50)						
Tag length: 4						
Extended Supported Rates: 6(B) (0x8c)						
Extended Supported Rates: 12(B) (0x98)						
Extended Supported Rates: 24(B) (0xb0)						
Extended Supported Rates: 48 (0x60)						
► Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap						
► Tag: ERP Information						
► Tag: HT Capabilities (802.11n D1.10)						
0050	06 12 24 48 6c 03 01 0c 32 04 8c 98 b0 60 05 05	05_WIFI_Fon			..SH1.. 2....	
0050	01 03 00 4a 01 2a 01 00 2d 1a 8c 01 16 ff ff 00				...J*.. -.....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	18 00 50 f2 02 01 01 80 00 03 a4 00 00 27 a4 00				..P.... .....	
0... .... .... .... = Immediate Block Ack: Not Implemented						
▼ Tagged parameters (140 bytes)						
► Tag: SSID parameter set: NOS_WIFI_Fon						
► Tag: Supported Rates 1(B), 2(B), 5.5(B), 11(B), 9, 18, 36, 54, [Mbit/sec]						
Tag Number: Supported Rates (1)						
Tag length: 8						
Supported Rates: 1(B) (0x82)						
Supported Rates: 2(B) (0x84)						
Supported Rates: 5.5(B) (0x8b)						
Supported Rates: 11(B) (0x96)						
Supported Rates: 9 (0x12)						
Supported Rates: 18 (0x24)						
Supported Rates: 36 (0x48)						
Supported Rates: 54 (0x6c)						
► Tag: DS Parameter set: Current Channel: 12						
► Tag: Extended Supported Rates 6(B), 12(B), 24(B), 48, [Mbit/sec]						
Tag Number: Extended Supported Rates (50)						
Tag length: 4						
Extended Supported Rates: 6(B) (0x8c)						
Extended Supported Rates: 12(B) (0x98)						
Extended Supported Rates: 24(B) (0xb0)						
Extended Supported Rates: 48 (0x60)						
► Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap						
► Tag: ERP Information						
► Tag: HT Capabilities (802.11n D1.10)						
0040	4f 52 5f 57 49 46 49 5f 46 6f 6e 01 08 82 84 8b	05_WIFI_Fon				
0050	06 12 24 48 6c 03 01 0c 32 04 8c 98 b0 60 05 05	05_WIFI_Fon			..SH1.. 2....	
0050	01 03 00 4a 01 2a 01 00 2d 1a 8c 01 16 ff ff 00				...J*.. -.....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00				...=.... .....	
0050	18 00 50 f2 02 01 01 80 00 03 a4 00 00 27 a4 00				..P.... .....	
0... .... .... .... = Immediate Block Ack: Not Implemented						



No.	Time	Source	Destination	Protocol	Length	Info
1300	53.746911	Apple_10:6a:f5	Broadcast	802.11	155	Probe Request, SN=2516, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
2467	70.147855	ea:a4:64:7b:b9:7a	Broadcast	802.11	167	Probe Request, SN=2540, FN=0, Flags=.....C, SSID=ZIRE-PT-431
2468	70.149698	ea:a4:64:7b:b9:7a	Broadcast	802.11	155	Probe Request, SN=2541, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
2469	70.149792	HironTe_af:b1:98	ea:a4:64:7b:b9:7a	802.11	411	Probe Response, SN=2332, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2471	70.150537	HironTe_af:b1:98	ea:a4:64:7b:b9:7a	802.11	411	Probe Response, SN=2333, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2473	70.151237	HironTe_af:b1:98	ea:a4:64:7b:b9:7a	802.11	411	Probe Response, SN=2334, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2475	70.151709	HironTe_af:b1:99	ea:a4:64:7b:b9:7a	802.11	201	Probe Response, SN=2335, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
2477	70.152099	HironTe_af:b1:99	ea:a4:64:7b:b9:7a	802.11	201	Probe Response, SN=2336, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
2479	70.152570	HironTe_af:b1:99	ea:a4:64:7b:b9:7a	802.11	201	Probe Response, SN=2337, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
2603	72.179215	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2563, FN=0, Flags=.....C, SSID=FlyingNet
2606	72.179924	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2346, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2608	72.180590	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2347, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2614	72.181275	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2348, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2616	72.201570	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2565, FN=0, Flags=.....C, SSID=FlyingNet
2617	72.202150	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2350, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2619	72.202807	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2351, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2621	72.203485	HironTe_af:b1:98	Apple_10:6a:f5	802.11	411	Probe Response, SN=2352, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
2650	72.488998	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2585, FN=0, Flags=.....C, SSID=FlyingNet
2653	72.502553	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2586, FN=0, Flags=.....C, SSID=FlyingNet
2677	72.568343	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2589, FN=0, Flags=.....C, SSID=FlyingNet
2678	72.578258	Apple_10:6a:f5	Broadcast	802.11	164	Probe Request, SN=2590, FN=0, Flags=.....C, SSID=FlyingNet
4455	82.621343	7:ce:a6:ff:ff:a2:cc	Broadcast	802.11	71	Probe Request, SN=62, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
4493	82.726818	7:ce:a6:ff:ff:a2:cc	Broadcast	802.11	71	Probe Request, SN=64, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
4494	82.728646	7:ce:a6:ff:ff:a2:cc	Broadcast	802.11	218	Probe Request, SN=65, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)

► Frame 1300: 155 bytes on wire (1240 bits), 155 bytes captured (1240 bits)  
Radiotap Header v0, Length 25  
802.11 radio information  
▼ IEEE 802.11 Probe Request, Flags: .....

Type/Subtype: Probe Request (0x0004)  
Frame Control Field: 0x4000  
.... .00 = Version: 0  
.... 00.. = type: Management frame (0)  
0100 .... = Subtype: 4  
► Flags: 0x00  
.0000 0000 0000 0000 = Duration: 0 microseconds  
Receiver address: Broadcast (ffff:ffff:ffff:ffff)  
Destination address: Broadcast (ffff:ffff:ffff:ffff)  
Transmitter address: Apple\_10:6a:f5 (64:9:be:10:6a:f5)

0000	00 00 19 00 6f 08 00 00	23 3e 62 04 00 00 00 00	.....#>b.....
0010	10 02 a3 09 80 04 b9 a9	00 40 00 00 00 ff ff ff	.....@.....
0020	ff ff ff 64 9a be 10 6a	f5 ff ff ff ff ff ff 40	.....d...j.....@
0030	9d 00 00 01 04 02 04 0b	16 32 08 0c 12 18 24 30	.....2.....\$0
0040	48 60 6c 03 01 0b 2d 1a	21 40 17 ff 00 00 00 00	H'1'.....@.....
0050	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....@.....

11. Identifique um probing request para o qual tenha havido um probing response. Face ao endereçamento usado, indique a que sistemas são endereçadas estas tramas e explique qual o propósito das mesmas.

Uma frame *probe request* é enviada por um host wireless para todos os APs na sua vizinhança. Estes respondem com uma trama *probe response* e o host pode então escolher o AP com o qual se pretende associar, dentro daqueles que enviaram resposta ao seu pedido.

Depois de selecionar o AP com o qual se pretende conectar, o host envia uma trama *association request* para esse mesmo AP, e este responde com uma trama *association response*.

Duas tramas que representam esta situação são a trama 2468 e 2469, que se tratam respetivamente do *probe request* e do *probe response*, e que podemos analisar na imagem da alínea anterior.

12. Identifique uma sequência de tramas que corresponda a um processo de associação completo entre a STA e o AP, incluindo a fase de autenticação.

1º Trama 2486 – Ocorre autenticação da STA.

2º Tramas 2487 e 2488 – Reconhecimento da receção da autenticação da STA por parte do AP e autenticação do AP.

3º Tramas 2489 e 2490 – STA envia trama de *Acknowledgement* e faz um pedido de associação ao AP (*association request*).

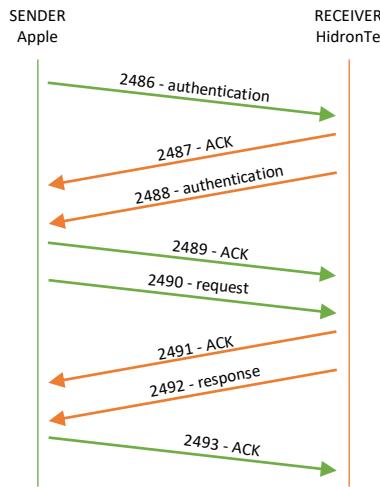
4º Tramas 2491 e 2492 – Envio de uma trama *Acknowledgement* por parte do AP e efetua resposta ao pedido de associação (*association response*).

5º Trama 2493 – STA envia trama de *acknowledgement* relativa à resposta do AP.

A imagem que se segue ilustra o processo descrito.

2486	70.361782	Apple_10:6a:f5	HitronTe_af:b1:98	802.11	70 Authentication, SN=2542, FN=0, Flags=.....C
2487	70.362050		Apple_10:6a:f5 (64..	802.11	39 Acknowledgement, Flags=.....C
2488	70.381869	HitronTe_af:b1:98	Apple_10:6a:f5	802.11	59 Authentication, SN=2338, FN=0, Flags=.....C
2489	70.381878		HitronTe_af:b1:98 ..	802.11	39 Acknowledgement, Flags=.....C
2490	70.383512	Apple_10:6a:f5	HitronTe_af:b1:98	802.11	175 Association Request, SN=2543, FN=0, Flags=.....C, SSID=FlyingNet
2491	70.383873		Apple_10:6a:f5 (64..	802.11	39 Acknowledgement, Flags=.....C
2492	70.389339	HitronTe_af:b1:98	Apple_10:6a:f5	802.11	225 Association Response, SN=2339, FN=0, Flags=.....C
2493	70.389352		HitronTe_af:b1:98 ..	802.11	39 Acknowledgement, Flags=.....C

13. Efetue um diagrama que ilustre a sequência de todas as tramas trocadas no processo.



14. Considere a trama de dados nº455. Sabendo que o campo Frame Control contido no cabeçalho das tramas 802.11 permite especificar a direccionalidade das tramas, o que pode concluir face à direccionalidade dessa trama, será local à WLAN?

Não é local à WLAN, tal como indica a flag *TO DS:0 FROM DS:1*. Na trama conseguimos ver que a trama recebida vem do sistema de distribuição (HitronTe\_af:b1:98) para a STA (Apple\_71:41:a1), através do AP (HitronTe\_af:b1:98).

Screenshot of Wireshark showing network traffic analysis. The packet list pane shows several frames, with frame 455 highlighted. The details pane provides a detailed breakdown of frame 455, including fields like Source (HitronTe\_af:b1:98), Destination (Apple\_71:41:a1), Protocol (802.11), Length (226), and Info (QoS Data, SN=276, FN=0, Flags=.p....F.C). The bytes pane shows the raw hex and ASCII data of the frame.

15. Para a trama nº455, transcreva os endereços MAC em uso, identificando qual o endereço MAC correspondente ao host sem fios (STA), ao AP e ao router de acesso ao sistema de distribuição.

O STA tem o endereço MAC Apple\_71:41:a1, o AP HitronTe\_af:b1:98 e o router de acesso ao sistema tem o endereço MAC HitronTe\_af:b1:98.

Screenshot of Wireshark showing network traffic analysis. The packet list pane shows several frames, with frame 455 highlighted. The details pane provides a detailed breakdown of frame 455, including fields like Source (HitronTe\_af:b1:98), Destination (Apple\_71:41:a1), Protocol (802.11), Length (226), and Info (QoS Data, SN=276, FN=0, Flags=.p....F.C). The bytes pane shows the raw hex and ASCII data of the frame.

## 16. Como interpreta a trama nº457 face à sua direccionalidade e endereço MAC?

Nesta trama a direccionalidade é To DS: 1 From DS: 0, indicando que a trama está a ser transmitida para fora da rede local. O sender/transmitter é a STA (d8:a2:5e:71:41:a1), o receiver é AP (bc:14:01:af:b1:98) e o destination é o Router (bc:14:01:af:b1:98). O pacote chega da STA ao sistema de distribuição pelo AP.

No.	A	Time	Source	Destination	Protocol	Length	Info
447	18.432190		HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2443, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
448	18.433841		HitronTe_af:b1:99	Broadcast	802.11	295	Beacon frame, SN=2444, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
449	18.534506		HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2445, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
450	18.536180		HitronTe_af:b1:99	Broadcast	802.11	295	Beacon frame, SN=2446, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
451	18.536165		Apple_71:41:a1	HitronTe_af:b1:98	802.11	68	Null function (No data), SN=1750, FN=0, Flags=.....TC
452	18.536187		Apple_71:41:a1	(d8:a2:5e:71:41:a1)	802.11	39	Acknowledgement, Flags=.....C
453	18.536401		HitronTe_af:b1:98	Apple_71:41:a1	802.11	49	802.11 Block Ack Req, Flags=.....C
454	18.536460		Apple_71:41:a1	(d8:a2:5e:71:41:a1)	802.11	57	802.11 Block Ack, Flags=.....C
455	18.536644		HitronTe_af:b1:98	Apple_71:41:a1	802.11	226	QoS Data, SN=276, FH=0, Flags=p....F.C
456	18.536653		HitronTe_af:b1:98	(d8:a2:5e:71:41:a1)	802.11	36	Acknowledgement, Flags=.....C
457	18.539762		Apple_71:41:a1	HitronTe_af:b1:98	802.11	178	QoS Data, SN=1209, FN=0, Flags=p....TC
458	18.540043		Apple_71:41:a1	(d8:a2:5e:71:41:a1)	802.11	39	Acknowledgement, Flags=.....C
459	18.636998		HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2447, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

> Frame 457: 178 bytes on wire (1424 bits), 178 bytes captured (1424 bits)  
> Radiotap Header v0, Length 25  
> 802.11 radio information  
> IEEE 802.11 QoS Data, Flags: .p....TC  
Type/Subtype: QoS Data (0x0028)  
Frame Control Field: 0x8841  
.... .0.. = Version: 0  
.... 10.. = Type: Data frame (2)  
1000 .... = Subtype: 8  
▼ Flags: 0x41  
.... ..01 = DS status: Frame from STA to DS via an AP (To DS: 1 From DS: 0) (0x1)  
.... .0.. = More Fragments: This is the last fragment  
.... 0.. = Retry: Frame is not being retransmitted  
.... 0.. = PWR MGT: STA will stay up  
.... 0.. = More Data: No data buffered  
.... 1.. = Protected flag: Data is protected  
.... 0.. = Order flag: Not strictly ordered  
.... 0000 0001 0011 1010 = Duration: 314 microseconds  
Receiver address: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)  
Transmitter address: Apple\_71:41:a1 (d8:a2:5e:71:41:a1)  
Destination address: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)  
Source address: Apple\_71:41:a1 (d8:a2:5e:71:41:a1)  
BSS Id: HitronTe\_af:b1:98 (bc:14:01:af:b1:98)  
STA address: Apple\_71:41:a1 (d8:a2:5e:71:41:a1)  
.... .... 0000 = Fragment number: 0  
0100 1011 1001 .... = Sequence number: 1209  
Frame check sequence: 0x88cbfe48 [correct]  
[FCSError: Good]  
Data Control: 0x0000  
Data Control: 0x0000  
0010 14 02 a3 09 80 04 bd a9 00 88 41 3a 01 bc 14 01 .....A:....  
0020 af b1 98 d8 a2 5e 71 41 a1 bc 14 01 af b1 98 90 .....^A .....

## 17. Que subtípido de tramas de controlo são transmitidas ao longo da transferência de dados acima mencionada? Tente explicar porque razão têm de existir.

É transmitida uma trama de controlo de subtípido confirmação da receção sempre que não ocorre nenhum erro. Numa rede sem fios, a probabilidade de ocorrência de erros é muito grande relativamente a redes com fios, não existindo, contudo, nenhum método de deteção de erros no destino. Assim, o uso de tramas *acknowledgement* permite detetar a presença de erros na transmissão de dados. Após receber uma trama, a estação recetora envia ao transmissor uma trama deste tipo caso não tenham ocorrido erros. Se a estação transmissora não receber esta confirmação por parte do recetor durante um determinado intervalo de tempo após a transmissão, a trama é reenviada.

## 18. Para o exemplo em cima, verifique se está a ser usada a opção RTS/CTS na troca de dados entre a STA e o AP/Router da WLAN, identificando a direccionalidade das tramas e os sistemas envolvidos.

A opção RTS/CTS está a ser usada na troca de dados entre a STA e o AP/Router da WLAN, sendo estes os dois sistemas envolvidos nesta operação. Nas imagens apresentadas de seguida, podemos ver que as tramas 173 e 174 se tratam de um *request-to-send* (RTS) e um *clear-to-send* (CTS), respetivamente. Através da análise das imagens é também perceptível que a direccionalidade das tramas é *TO DS: 0 FROM DS: 0*, o que nos indica que estas estão a operar localmente à WLAN.

A STA envia uma trama *RTS* ao AP, informando-o que lhe pretende transmitir dados e este, posteriormente, informa o AP, com uma trama *CTS*, que os pode enviar. A trama *CTS* inclui um valor temporal que informa as outras estações na WLAN que está a ser processado um envio de dados, evitando assim possíveis colisões.

Apply a display filter ... <?>/						
No.	A	Time	Source	Destination	Protocol	Length Info
170	6.657836		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2214, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
171	6.657917		HitronTe_af:b1:98 ..	Apple_10:6a:f5 (64..)	802.11	49 802.11 Block Ack Req, Flags=.....C
172	6.658010		Apple_10:6a:f5 (64..)	HitronTe_af:b1:98 ..	802.11	57 802.11 Block Ack, Flags=.....C
173	6.658172		Apple_10:6a:f5 (64..)	HitronTe_af:b1:98 ..	802.11	45 Request-to-send, Flags=.....C
174	6.658178			Apple_10:6a:f5 (64..)	802.11	39 Clear-to-send, Flags=.....C
175	6.658301		HitronTe_af:b1:98 ..	Apple_10:6a:f5 (64..)	802.11	57 802.11 Block Ack, Flags=.....C
176	6.720902		Apple_10:6a:f5	HitronTe_af:b1:98	802.11	53 Null function (No data), SN=2491, FN=0, Flags=...P...TC
177	6.720922			Apple_10:6a:f5 (64..)	802.11	39 Acknowledgement, Flags=.....C
178	6.758565		HitronTe_af:b1:98	Broadcast	802.11	296 Beacon frame, SN=2215, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
179	6.760067		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2216, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
180	6.860891		HitronTe_af:b1:98	Broadcast	802.11	296 Beacon frame, SN=2217, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
181	6.862481		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2218, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
182	6.862596		Apple_10:6a:f5	IPv4mcast_fb	802.11	179 Data, SN=2235, FN=0, Flags=..pm...F.C
183	6.862670				802.11	100 Data, SN=2236, FN=0, Flags= .. F.C
► Frame 173: 45 bytes on wire (360 bits), 45 bytes captured (360 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
▼ IEEE 802.11 Request-to-send, Flags: .....						
Type/Subtype: Request-to-send (0x001b)						
▼ Frame Control Field: 0xb400						
.... .00 = Version: 0						
.... 01.. = Type: Control frame (1)						
1011 .... = Subtype: 11						
▼ Flags: 0x00						
.... .00 = DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 From DS: 0) (0x0)						
.... .0.. = More Fragments: This is the last fragment						
.... 0... = Retry: Frame is not being retransmitted						
....0 .... = PWR MGT: STA will stay up						
..0.. .... = More Data: No data buffered						
.0... .... = Protected flag: Data is not protected						
0... .... = Order flag: Not strictly ordered						
.0000 0000 1010 0010 = Duration: 162 microseconds						
Receiver address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
Transmitter address: Apple_10:6a:f5 (64:9a:be:10:6a:f5)						
Frame check sequence: 0xfce4fa85 [correct]						
[FCS Status: Good]						

Apply a display filter ... <?>/						
No.	A	Time	Source	Destination	Protocol	Length Info
170	6.657836		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2214, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
171	6.657917		HitronTe_af:b1:98 ..	Apple_10:6a:f5 (64..)	802.11	49 802.11 Block Ack Req, Flags=.....C
172	6.658010		Apple_10:6a:f5 (64..)	HitronTe_af:b1:98 ..	802.11	57 802.11 Block Ack, Flags=.....C
173	6.658172		Apple_10:6a:f5 (64..)	HitronTe_af:b1:98 ..	802.11	45 Request-to-send, Flags=.....C
174	6.658178			Apple_10:6a:f5 (64..)	802.11	39 Clear-to-send, Flags=.....C
175	6.658301		HitronTe_af:b1:98 ..	Apple_10:6a:f5 (64..)	802.11	57 802.11 Block Ack, Flags=.....C
176	6.720902		Apple_10:6a:f5	HitronTe_af:b1:98	802.11	53 Null function (No data), SN=2491, FN=0, Flags=...P...TC
177	6.720922			Apple_10:6a:f5 (64..)	802.11	39 Acknowledgement, Flags=.....C
178	6.758565		HitronTe_af:b1:98	Broadcast	802.11	296 Beacon frame, SN=2215, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
179	6.760067		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2216, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
180	6.860891		HitronTe_af:b1:98	Broadcast	802.11	296 Beacon frame, SN=2217, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
181	6.862481		HitronTe_af:b1:99	Broadcast	802.11	205 Beacon frame, SN=2218, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
182	6.862596		Apple_10:6a:f5	IPv4mcast_fb	802.11	179 Data, SN=2235, FN=0, Flags=..pm...F.C
183	6.862670				802.11	100 Data, SN=2236, FN=0, Flags= .. F.C
► Frame 174: 39 bytes on wire (312 bits), 39 bytes captured (312 bits)						
► Radiotap Header v0, Length 25						
► 802.11 radio information						
▼ IEEE 802.11 Clear-to-send, Flags: .....						
Type/Subtype: Clear-to-send (0x001c)						
▼ Frame Control Field: 0xc400						
.... .00 = Version: 0						
.... 01.. = Type: Control frame (1)						
1100 .... = Subtype: 12						
▼ Flags: 0x00						
.... .00 = DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 From DS: 0) (0x0)						
.... .0.. = More Fragments: This is the last fragment						
.... 0... = Retry: Frame is not being retransmitted						
....0 .... = PWR MGT: STA will stay up						
..0.. .... = More Data: No data buffered						
.0... .... = Protected flag: Data is not protected						
0... .... = Order flag: Not strictly ordered						
.0000 0000 0111 0110 = Duration: 118 microseconds						
Receiver address: Apple_10:6a:f5 (64:9a:be:10:6a:f5)						
Frame check sequence: 0x437c3320 [correct]						
[FCS Status: Good]						

## **CONCLUSÃO**

Com a realização deste trabalho prático, exploramos vários aspetos do protocolo IEEE 802.11, tais como o formato das tramas, o endereçamento dos componentes envolvidos na comunicação sem fios, bem como a operação do protocolo.

Vimos de perto o funcionamento do scanning ativo e do scanning passivo, e aprendemos que existem três tipos de tramas: as tramas de gestão, responsáveis por estabelecer e manter a comunicação entre as STAs; as tramas de controlo, que ajudam na troca de tramas de dados entre as STAs; e as tramas de dados, responsáveis pela transmissão e comunicação de dados.