

TP3: Redes Sem Fios

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PL5 2º Turno

4. Acesso Rádio

1. A rede sem fios está a operar na frequência 2467MHz que corresponde ao canal 12.

```
> Frame 325: 296 bytes on wire (2368 bits), 296 bytes captured (2368 bits)
> Radiotap Header v0, Length 25
▼ 802.11 radio information
  PHY type: 802.11g (ERP) (6)
  Short preamble: False
  Proprietary mode: None (0)
  Data rate: 1,0 Mb/s
  Channel: 12
  Frequency: 2467MHz
  Signal strength (dBm): -61dBm
  Noise level (dBm): -87dBm
  Signal/noise ratio (dB): 26dB
  TSF timestamp: 32907166
> [Duration: 2360µs]
```

```

  802.11 radio information
    PHY type: 802.11g (ERP) (6)

```

```

Fixed parameters (12 bytes)
└─ Tagged parameters (231 bytes)
    └─ Tag: SSID parameter set: FlyingNet
        └─ 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: Vendor Specific: Microsoft Corp.: WPS
                Tag: Traffic Indication Map (TIM): DTIM 2 of 0 bitmap
                Tag: ERP Information

```

4. Sim pertence. O valor do identificador do tipo é 0 e do subtipo é 8. Estão especificados na Management frame.

```

325 13.107... HitronTe_af:b1:98      Broadcast      802.11      296 Beacon frame, SN=2339, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
<
  IEEE 802.11 Beacon frame, Flags: .....C
    Type/Subtype: Beacon frame (0x0008)
    Frame Control Field: 0x8000
      .... ..00 = Version: 0
      .... ..00.. = Type: Management frame (0)
      1000 .... = Subtype: 8
    > Flags: 0x00
      .000 0000 0000 0000 = Duration: 0 microseconds
      Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)
      Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
      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

```

5. Para construir a nossa resposta utilizamos primeiro um filtro wlan.bssid == bc:14:01:af:b1:98, e depois sem o filtro.

wlan.bssid == bc:14:01:af:b1:98							
No.	Time	Source	Destination	Protocol	Length	Info	
308	12.185...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2321, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
310	12.288...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2323, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
312	12.390...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2325, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
313	12.492...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2327, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
315	12.595...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2329, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
317	12.697...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2331, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
319	12.800...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2333, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
321	12.902...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2335, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
323	13.005...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2337, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
325	13.107...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2339, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	

> Fixed parameters (12 bytes)							
▼ Tagged parameters (231 bytes)							
▼ Tag: SSID parameter set: FlyingNet							
Tag Number: SSID parameter set (0)							
Tag length: 9							
SSID: FlyingNet							
▼ 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)							
0030	92 e9 41 7d ae 0b 01 00	00 64 00 31 0c 00 09 46	..A)....d.1...f				
0040	bc 79 69 6e 67 4e 65 74	01 08 82 84 8b 96 12 24	FlyingNet.....\$				
0050	48 6c 03 01 0c 32 04 8c	98 b0 60 dd 27 00 50 f2	Hl...2...'.P.				
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 a8	80 bc 14 01 af b1 98 10	.-(.....				
0080	3c 00 01 01 05 04 02 03	00 50 2a 01 00 2d 1a 8c	<.....P*.....				
0090	01 16 ff ff 00 00 00 00	00 00 00 00 00 00 00 00	.....			
00a0	00 00 00 00 00 00 00 00	00 3d 16 0c 00 04 00 00=.....				
00b0	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....			
00c0	00 7f 01 01 dd 1a 00 50	f2 01 01 00 00 50 f2 02	.....P.....P..				
00d0	02 00 00 50 f2 02 00 50	f2 04 01 00 00 50 f2 02	...P...P.....P..				
00e0	30 18 01 00 00 0f ac 02	02 00 00 0f ac 02 00 0f	0.....				
00f0	ac 04 01 00 00 0f ac 02	00 00 dd 18 00 50 f2 02	.....P..				
0100	01 01 80 00 03 a4 00 00	27 a4 00 00 42 43 5e 00	.....'...BC^.				

No.	Time	Source	Destination	Protocol	Length	Info	
316	12.597...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2330, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon	
317	12.697...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2331, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
318	12.699...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2332, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon	
319	12.800...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2333, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
320	12.801...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2334, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon	
321	12.902...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2335, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
322	12.904...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2336, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon	
323	13.005...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2337, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	
324	13.006...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=2338, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon	
325	13.107...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2339, FN=0, Flags=.....C, BI=100, SSID=FlyingNet	

> IEEE 802.11 Wireless Management							
> Fixed parameters (12 bytes)							
▼ Tagged parameters (231 bytes)							
▼ Tag: SSID parameter set: FlyingNet							
Tag Number: SSID parameter set (0)							
Tag length: 9							
SSID: FlyingNet							
▼ 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)							
0030	92 e9 41 7d ae 0b 01 00	00 64 00 31 0c 00 09 46	..A)....d.1...f				
0040	bc 79 69 6e 67 4e 65 74	01 08 82 84 8b 96 12 24	FlyingNet.....\$				
0050	48 6c 03 01 0c 32 04 8c	98 b0 60 dd 27 00 50 f2	Hl...2...'.P.				
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 a8	80 bc 14 01 af b1 98 10	.-(.....				
0080	3c 00 01 01 05 04 02 03	00 50 2a 01 00 2d 1a 8c	<.....P*.....				
0090	01 16 ff ff 00 00 00 00	00 00 00 00 00 00 00 00	.....			
00a0	00 00 00 00 00 00 00 00	00 3d 16 0c 00 04 00 00=.....				
00b0	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....			
00c0	00 7f 01 01 dd 1a 00 50	f2 01 01 00 00 50 f2 02	.....P.....P..				
00d0	02 00 00 50 f2 02 00 50	f2 04 01 00 00 50 f2 02	...P...P.....P..				
00e0	30 18 01 00 00 0f ac 02	02 00 00 0f ac 02 00 0f	0.....				
00f0	ac 04 01 00 00 0f ac 02	00 00 dd 18 00 50 f2 02	.....P..				
0100	01 01 80 00 03 a4 00 00	27 a4 00 00 42 43 5e 00	.....'...BC^.				

6. O intervalo é de 0.102400 segundos. É verificada, pois a cada 0.102400 segundos ele envia um *beacon*, porém nesta rede contenciosa é necessário competir para ter controlo do acesso, como tal caso ele demore mais tempo a tomar controlo é porque o acesso está ocupado por um anterior e por isso este novo *beacon* terá de esperar.

```
Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
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 0010 0011 .... = Sequence number: 2339
Frame check sequence: 0x72d0003e [unverified]
[FCS Status: Unverified]
▼ IEEE 802.11 Wireless Management
  ▼ Fixed parameters (12 bytes)
    Timestamp: 1149683712489
    Beacon Interval: 0,102400 [Seconds]
    > Capabilities Information: 0x0c31
    > Tagged parameters (231 bytes)
```

0030	92 e9 41 7d ae 0b 01 00 00 64 00 31 0c 00 09 46	--A}....-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 0c 32 04 8c 98 b0 60 dd 27 00 50 f2	Hl...2...`..P.
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 a8 80 bc 14 01 af b1 98 10	-(....
0080	3c 00 01 01 05 04 02 03 00 50 2a 01 00 2d 1a 8c	<.....P*.....
0090	01 16 ff ff 00 00 00 00 00 00 00 00 00 00 00 00	.....
00a0	00 00 00 00 00 00 00 00 00 3d 16 0c 00 04 00 00=.....
00b0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
00c0	00 7f 01 01 dd 1a 00 50 f2 01 01 00 00 50 f2 02	.....P.....P..
00d0	02 00 00 50 f2 02 00 50 f2 04 01 00 00 50 f2 02	...P...P.....P..
00e0	30 18 01 00 00 0f ac 02 02 00 00 0f ac 02 00 0f	0.....
00f0	ac 04 01 00 00 0f ac 02 00 00 dd 18 00 50 f2 02	.....P..
0100	01 01 80 00 03 a4 00 00 27 a4 00 00 42 43 5e 00	.....'....BC^

7. Temos o endereço ff:ff:ff:ff:ff:ff, o endereço bc:14:01:af:b1:98 e o endereço bc:14:01:af:b1:99.

```
Type/Subtype: Beacon frame (0x0008)
▼ Frame Control Field: 0x8000
  .... ..00 = Version: 0
  .... 00.. = Type: Management frame (0)
  1000 .... = Subtype: 8
  > Flags: 0x00
  .000 0000 0000 0000 = Duration: 0 microseconds
  Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)
  Destination address: Broadcast (ff:ff:ff:ff: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 0010 0010 .... = Sequence number: 2338
  Frame check sequence: 0x5b047d41 [unverified]
```

20	ff ff ff bc 14 01 af b1 98 bc 14 01 af b1 98 30	--A}....-d-1...F
30	92 e9 41 7d ae 0b 01 00 00 64 00 31 0c 00 09 46	lyingNet\$
40	6c 79 69 6e 67 4e 65 74 01 08 82 84 8b 96 12 24	Hl...2...`..P.
50	48 6c 03 01 0c 32 04 8c 98 b0 60 dd 27 00 50 f2	--J....D....G..(
60	04 10 4a 00 01 10 10 44 00 01 02 10 47 00 10 28	-(....
70	80 28 80 28 80 18 80 a8 80 bc 14 01 af b1 98 10	<.....P*.....
80	3c 00 01 01 05 04 02 03 00 50 2a 01 00 2d 1a 8c	.....
90	01 16 ff ff 00 00 00 00 00 00 00 00 00 00 00 00=.....
a0	00 00 00 00 00 00 00 00 00 3d 16 0c 00 04 00 00	.....
b0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
c0	00 7f 01 01 dd 1a 00 50 f2 01 01 00 00 50 f2 02	.....P.....P..
d0	02 00 00 50 f2 02 00 50 f2 04 01 00 00 50 f2 02	...P...P.....P..
e0	30 18 01 00 00 0f ac 02 02 00 00 0f ac 02 00 0f	0.....
f0	ac 04 01 00 00 0f ac 02 00 00 dd 18 00 50 f2 02	.....P..

```
Type/Subtype: Beacon frame (0x0008)
▼ Frame Control Field: 0x8000
  .... ..00 = Version: 0
  .... 00.. = Type: Management frame (0)
  1000 .... = Subtype: 8
  > Flags: 0x00
  .000 0000 0000 0000 = Duration: 0 microseconds
  Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)
  Destination address: Broadcast (ff:ff:ff:ff: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 0010 0010 .... = Sequence number: 2338
  Frame check sequence: 0x5b047d41 [unverified]
```

100	00 00 19 00 6f 08 00 00 eb 98 f4 01 00 00 00 00	....o.....
110	10 02 a3 09 80 04 c0 a9 00 80 00 00 00 ff ff ff-.....
120	ff ff ff bc 14 01 af b1 99 bc 14 01 af b1 99 20	--A}....-d-1...F
130	92 35 bb 7b ae 0b 01 00 00 64 00 21 0c 00 0c 4e	-5{.....-d-!...N
140	4f 53 5f 57 49 46 49 5f 46 6f 6e 01 08 82 84 8b	OS_WIFI_Fon....
150	96 12 24 48 6c 03 01 0c 32 04 8c 98 b0 60 05 05	--\$Hl...2.....
160	00 03 00 4a 01 2a 01 00 2d 1a 8c 01 16 ff ff 00	--J.*.....
170	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	.....
180	00 00 00 00 3d 16 0c 00 04 00 00 00 00 00 00=.....
190	00 00 00 00 00 00 00 00 00 00 00 00 7f 01 01 dd	.....
1a0	18 00 50 f2 02 01 01 80 00 03 a4 00 00 27 a4 00	..P.....'....
1b0	00 42 43 5e 00 62 32 2f 00 0b 05 03 00 0a 12 7a	..BC^b2/.....z
1c0	dd 07 00 0c 43 00 00 00 00 e1 7d 94 5b	....C.....}[

8. wlan.fc.type_subtype

wlan.fc.type_subtype						
No.	Time	Source	Destination	Protocol	Length	Info
24...	69.939...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=3449, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
24...	69.941...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=3450, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
24...	70.041...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=3451, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
24...	70.043...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=3452, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
24...	70.144...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=3453, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
24...	70.145...	HitronTe_af:b1:99	Broadcast	802.11	205	Beacon frame, SN=3454, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
24...	70.147...	ea:a4:64:7b:b9:7a	Broadcast	802.11	167	Probe Request, SN=2540, FN=0, Flags=.....C, SSID=2WIRE-PT-431
24...	70.149...	ea:a4:64:7b:b9:7a	Broadcast	802.11	155	Probe Request, SN=2541, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
24...	70.149...	HitronTe_af:b1:98	ea:a4:64:7b:...	802.11	411	Probe Response, SN=2332, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
24...	70.149...	HitronTe_af:...	HitronTe_af:...	802.11	39	Acknowledgement, Flags=.....C
<						
> Frame 2469: 411 bytes on wire (3288 bits), 411 bytes captured (3288 bits)						
> Radiotap Header v0, Length 25						
> 802.11 radio information						
IEEE 802.11 Probe Response, Flags: .....C						
Type/Subtype: Probe Response (0x0005)						
Frame Control Field: 0x5000						
.... 00 = Version: 0						
.... 00.. = Type: Management frame (0)						
0101 ... = Subtype: 5						
> Flags: 0x00						
.000 0000 0011 0010 = Duration: 50 microseconds						
Receiver address: ea:a4:64:7b:b9:7a (ea:a4:64:7b:b9:7a)						
Destination address: ea:a4:64:7b:b9:7a (ea:a4:64:7b:b9:7a)						
Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)						
0010	12 0c a3 09 80 04 be a9	00 50 00 32 00 ea a4 64	.....	P-2...		
0020	7b b9 7a bc 14 01 af b1	98 bc 14 01 af b1 98 c0	{z.....			
0030	91 84 ad e3 b1 0b 01 00	00 64 00 31 0c 00 09 46	.....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 0c 2a 01 00	32 04 8c 98 b0 60 2d 1a	H1....*	2.....		
0060	8c 01 16 ff ff 00 00 00	00 00 00 00 00 00 00 00	.....		
0070	00 00 00 00 00 00 00 00	00 00 3d 16 0c 00 04 00	.....		
0080	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00	.....		
0090	00 00 3e 01 00 dd 1a 00	50 f2 01 01 00 00 50 f2	..>.....	P.....P		
00a0	02 02 00 00 50 f2 02 00	50 f2 04 01 00 00 50 f2	....P....	P.....P		
00b0	02 30 18 01 00 00 0f ac	02 02 00 00 0f ac 02 00	0.....			
00c0	0f ac 04 01 00 00 0f ac	02 00 00 dd 18 00 50 f2	.....P			
00d0	02 01 01 80 00 03 a4 00	00 27 a4 00 00 42 43 5e	.....	'....BC^		
00e0	00 62 32 2f 00 0b 05 02	00 0b 12 7a 7f 01 dd	b2/.....	z		

9. wlan.fc.type_subtype == 4 || wlan.fc.type_subtype == 5

24...	70.149...	ea:a4:64:7b:b9:7a	Broadcast	802.11	155	Probe Request, SN=2541, FN=0, Flags=.....C, SSID=Wildcard (Broadcast)
24...	70.149...	HitronTe_af:b1:98	ea:a4:64:7b:...	802.11	411	Probe Response, SN=2332, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

Um *probing request* é um *frame* especial enviado por uma estação cliente ao solicitar informações de qualquer ponto de acesso especificado pelo SSID, ou por todos os pontos de acesso na área especificados com o *Broadcast* SSID.

6. Processo de Associação

10.

Filter for Association Requests:

Filter for Association Responses:

wlan.fc.type_subtype == 0

wlan.fc.type_subtype == 1

wlan.fc.type_subtype == 0 || wlan.fc.type_subtype == 1						
No.	Time	Source	Destination	Protocol	Length	Info
24...	70.383...	Apple_10:6a:f5	HitronTe_af:...	802.11	175	Association Request, SN=2543, FN=0, Flags=.....C, SSID=FlyingNet
24...	70.389...	HitronTe_af:b1:98	Apple_10:6a:f5	802.11	225	Association Response, SN=2339, FN=0, Flags=.....C

Filtro para a autenticação (wlan.fc.type_subtype == 11)

wlan.fc.type_subtype == 11						
No.	Time	Source	Destination	Protocol	Length	Info
24...	70.361...	Apple_10:6a:f5	HitronTe_af:...	802.11	70	Authentication, SN=2542, FN=0, Flags=.....C
24...	70.381...	HitronTe_af:b1:98	Apple_10:6a:f5	802.11	59	Authentication, SN=2338, FN=0, Flags=.....C

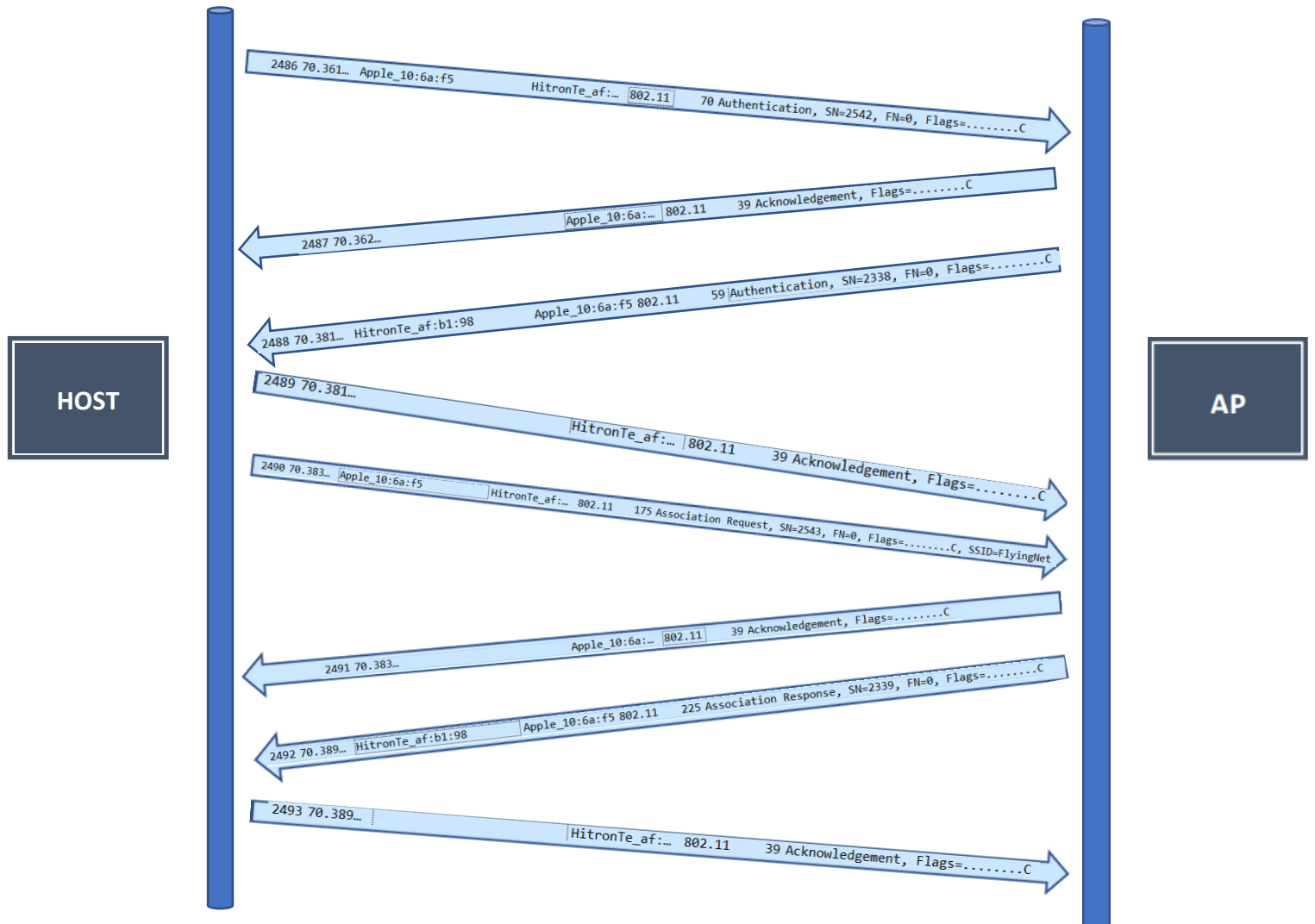
11.

2485 70.352...	Broadcom_04:...	802.11	39	Clear-to-send, Flags=.....C
2486 70.361...	HitronTe_af:...	802.11	70	Authentication, SN=2542, FN=0, Flags=.....C
2487 70.362...	Apple_10:6a:f5	802.11	39	Acknowledgement, Flags=.....C
2488 70.381...	HitronTe_af:b1:98	802.11	59	Authentication, SN=2338, FN=0, Flags=.....C
2489 70.381...	HitronTe_af:...	802.11	39	Acknowledgement, Flags=.....C
2490 70.383...	Apple_10:6a:f5	802.11	175	Association Request, SN=2543, FN=0, Flags=.....C, SSID=FlyingNet
2491 70.383...	Apple_10:6a:...	802.11	39	Acknowledgement, Flags=.....C
2492 70.389...	HitronTe_af:b1:98	802.11	225	Association Response, SN=2339, FN=0, Flags=.....C
2493 70.389...	HitronTe_af:...	802.11	39	Acknowledgement, Flags=.....C
2494 70.451...	HitronTe_af:b1:98	Broadcast	296	Beacon frame, SN=3459, FN=0, Flags=.....C, BI=100, SSID=FlyingNet

Frame 2485: 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:C
 Type/Subtype: Clear-to-send (0x001c)
 ✓ Frame Control Field: 0xc400
 00 = Version: 0
 01.. = Type: Control frame (1)
 1100 = Subtype: 12
 > Flags: 0x00
 .111 0001 0100 1000 = Duration: 29000 microseconds
 Receiver address: Broadcom_04:6a:f5 (e0:3e:44:04:6a:f5)
 Frame check sequence: 0x6b563b07 [unverified]
 [FCS Status: Unverified]

```

00 00 00 19 00 6f 08 00 00 4c a3 5f 05 00 00 00 00 ..... L .....
10 12 0c a3 09 80 04 c9 a8 00 24 00 48 71 e0 3e 44 ..... Hq>D
20 04 6a f5 07 3b 56 b6                                :j-;Vk
  
```



7. Transferência de Dados

12. A partir da direcionalidade desta trama podemos concluir que o *frame* desloca-se do DS para um STA via AP e que é local à WLAN, mas vem de fora.

Apply a display filter ... <Ctrl>/>

No.	Time	Source	Destination	Protocol	Length	Info
455	18.536...	HitronTe_af:b1:98	Apple_71:41:a1	802.11	226	QoS Data, SN=276, FN=0, Flags=.p...F.C
456	18.536...	HitronTe_af:b1:98	HitronTe_af:b1:98	802.11	39	Acknowledgement, Flags=.....C
457	18.539...	Apple_71:41:a1	HitronTe_af:b1:98	802.11	178	QoS Data, SN=1209, FN=0, Flags=.p....TC
458	18.540...	Apple_71:41:a1	HitronTe_af:b1:98	802.11	39	Acknowledgement, Flags=.....C
459	18.636...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2447, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
460	18.638...	HitronTe_af:b1:98	Broadcast	802.11	205	Beacon frame, SN=2448, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
461	18.739...	HitronTe_af:b1:98	Broadcast	802.11	296	Beacon frame, SN=2449, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
462	18.741...	HitronTe_af:b1:98	Broadcast	802.11	205	Beacon frame, SN=2450, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
463	18.780...	Apple_71:41:a1	HitronTe_af:b1:98	802.11	68	Null function (No data), SN=1751, FN=0, Flags=...P...TC
464	18.780...	Apple_71:41:a1	HitronTe_af:b1:98	802.11	39	Acknowledgement, Flags=.....C

<

> Frame 455: 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.C

Type/Subtype: QoS Data (0x0028)

> Frame Control Field: 0x8842

.000 0000 0010 0100 = Duration: 36 microseconds

Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)

Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)

Destination address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)

Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)

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

0001 0001 0100 = Sequence number: 276

```
0010 16 30 a3 09 80 04 bf 95 00 88 42 24 00 d8 a2 5e 0-....-B$...^
0020 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA-....-....@
0030 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c -....-....$K\
0040 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 --B-r-A_--?·1·i·
0050 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 --E-....-....Jv·
0060 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 -....-"-D-....
0070 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0·jP-...-M:|·-tn
0080 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b DOx-...8·-b-....+
0090 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7-...%w-...qA-...
00a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 -....-'P-...2#H[W·
00b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 -....-n-...~·T·
00c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ·?·Or·6w ^>7-·{·-
00d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA·@zY; ^·Q-...H·
00e0 46 ca F·
```

.... ..10 = DS status: Frame from DS to a STA via AP(To DS: 0 From DS: 1) (0x2)

.... .0.. = More Fragments: This is the last fragment

.... 00.. = 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

.000 0000 0010 0100 = Duration: 36 microseconds

Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)

```
0010 16 30 a3 09 80 04 bf a9 00 88 42 24 00 d8 a2 5e 0-....-B$...^
0020 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA-....-....@
0030 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c -....-....$K\
0040 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 --8-r-A_--?·1·i·
0050 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 --E-....-....Jv·
0060 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 -....-"-D-....
0070 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0·jP-...-M:|·-tn
0080 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b DOx-...8·-b-....+
0090 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7-...%w-...qA-...
00a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 -....-'P-...2#H[W·
00b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 -....-n-...~·T·
00c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ·?·Or·6w ^>7-·{·-
00d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA·@zY; ^·Q-...H·
00e0 46 ca F·
```

13.

```
> Frame Control Field: 0x8842
.000 0000 0010 0100 = Duration: 36 microseconds
Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
Destination address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
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
0001 0001 0100 .... = Sequence number: 276
Frame check sequence: 0xca46bf48 [unverified]
[FCS Status: Unverified]
> Qos Control: 0x0000
> CCMP parameters
```

```
Data (162 bytes)
10 16 30 a3 09 80 04 bf a9 00 88 42 24 00 d8 a2 5e .0.....-B$.-..^
20 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA.....@
30 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c .....$K\
40 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 ..8.r.A_..?.1.i.
50 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 ..E.....Jv.
60 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 ....."-D....
70 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0.jP...-M:|..tn
80 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b DOx...8- -b.....+
90 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7....%w-...qA...
a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 ..... 'P ..2#H[W.
b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 .....n.....~T.
c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ..?.Or-6w ^>7..{..
d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA.@zY; ..Q...H.
e0 46 ca F.
```

AP

```
▼ IEEE 802.11 QoS Data, Flags: .p....F.C
Type/Subtype: QoS Data (0x0028)
> Frame Control Field: 0x8842
.000 0000 0010 0100 = Duration: 36 microseconds
Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
Destination address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
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
0001 0001 0100 .... = Sequence number: 276
Frame check sequence: 0xca46bf48 [unverified]
[FCS Status: Unverified]
```

```
0010 16 30 a3 09 80 04 bf a9 00 88 42 24 00 d8 a2 5e .0.....-B$.-..^
0020 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA.....@
0030 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c .....$K\
0040 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 ..8.r.A_..?.1.i.
0050 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 ..E.....Jv.
0060 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 ....."-D....
0070 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0.jP...-M:|..tn
0080 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b DOx...8- -b.....+
0090 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7....%w-...qA...
00a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 ..... 'P ..2#H[W.
00b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 .....n.....~T.
00c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ..?.Or-6w ^>7..{..
00d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA.@zY; ..Q...H.
00e0 46 ca F.
```


MAC do router de acesso ao sistema de distribuição (DS)

```
▼ IEEE 802.11 QoS Data, Flags: .p....F.C
  Type/Subtype: QoS Data (0x0028)
  > Frame Control Field: 0x8842
    .000 0000 0010 0100 = Duration: 36 microseconds
    Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
    Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
    Destination address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
    Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
    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
    0001 0001 0100 .... = Sequence number: 276
    Frame check sequence: 0xca46bf48 [unverified]
    [FCS Status: Unverified]

0010 16 30 a3 09 80 04 bf a9 00 88 42 24 00 d8 a2 5e 00 .....B$...^
0020 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA.....@
0030 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c .....$K\
0040 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 --8-r-A_--?·1·i·
0050 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 --E.....Jv·
0060 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 ..... " --D.....
0070 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0·jP...-M:|·-tn
0080 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b D0x...8·-b.....+
0090 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7....%w·...qA...
00a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 ..... 'P --2#H[W·
00b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 .....n.....T·
00c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ·?·Or·6w ^>7·-{-·
00d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA·@zY; --Q...H·
00e0 46 ca F·
```

MAC do *host* sem fios

```
▼ IEEE 802.11 QoS Data, Flags: .p....F.C
  Type/Subtype: QoS Data (0x0028)
  > Frame Control Field: 0x8842
    .000 0000 0010 0100 = Duration: 36 microseconds
    Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
    Transmitter address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
    Destination address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
    Source address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)
    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
    0001 0001 0100 .... = Sequence number: 276
    Frame check sequence: 0xca46bf48 [unverified]
    [FCS Status: Unverified]

0010 16 30 a3 09 80 04 bf a9 00 88 42 24 00 d8 a2 5e 00 .....B$...^
0020 71 41 a1 bc 14 01 af b1 98 bc 14 01 af b1 98 40 qA.....@
0030 11 00 00 13 11 00 20 02 00 00 00 eb 0f 24 4b 5c .....$K\
0040 d7 04 38 bd 72 bf 41 5f d1 06 3f e8 31 8d 69 e5 --8-r-A_--?·1·i·
0050 e7 86 45 fc a7 11 e9 c5 c4 13 1a 82 9b 4a 76 02 --E.....Jv·
0060 b2 06 fe f2 f5 b6 bb 22 e6 ba 44 b4 89 03 16 b5 ..... " --D.....
0070 7d 30 1b 6a 50 a7 12 e2 fb 4d 3a 7c 9d db 74 6e }0·jP...-M:|·-tn
0080 44 4f 78 14 bb f4 38 c7 f2 62 fc ae fe f8 d7 2b D0x...8·-b.....+
0090 37 f8 ef ba 8f 25 77 14 fc 81 0d 71 41 fa cd a3 7....%w·...qA...
00a0 d1 1a 06 99 15 f5 27 50 ce a4 32 23 48 5b 57 b9 ..... 'P --2#H[W·
00b0 aa c3 e7 cc 1b ed 9d 6e ee 18 84 f7 7e 9c 54 09 .....n.....T·
00c0 84 3f 82 4f 72 e5 36 77 5e 3e 37 e0 d1 7b ca b3 ·?·Or·6w ^>7·-{-·
00d0 2d 59 41 19 40 7a 59 3b 17 c8 51 11 18 d4 48 bf -YA·@zY; --Q...H·
00e0 46 ca F·
```

A partir do facto de que só estão dois endereços MAC diferentes em uso podemos concluir que apenas o router de acesso e o *host* sem fios participam na trama, fazendo o router papel de DS e AP.

14. A direccionalidade da trama é do STA para o DS através de um AP.

```

  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
    .000 0001 0011 1010 = Duration: 314 microseconds
    Receiver address: HitronTe_af:b1:98 (bc:14:01:af:b1:98)

0000 00 00 19 00 6f 08 00 00 a4 07 49 02 00 00 00 00  ....o...@I....
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  ....^qA.....
0030 4b 00 00 bc 24 00 20 02 00 00 00 f7 94 63 84 51  K...$. ....c-Q
0040 79 f5 cb 90 d6 b5 01 8c e4 11 b8 49 46 9f 98 d6  y.....IF...
0050 da d2 47 0c 08 9b 55 0f a0 3b b2 36 f2 c4 ff e7  ..G...U. ;-6...
0060 af e5 26 6d 2f 29 51 f0 cf 7f f2 a3 3d 5d 06 ad  ..&m/)Q. ....=]-
0070 78 08 26 f9 d2 72 13 c0 ca 55 c5 47 30 b1 dc bb  x-&-r...U-G0...
0080 d3 7e 3f b4 c4 48 f5 63 ef 95 e5 8e 8b 0f 8d e9  ~?..H.c .....
0090 3b 10 31 ad c8 70 d5 38 17 3d 05 84 17 0b 1a e7  ;.1..p.8 -=.....
00a0 76 92 c7 30 cb ee cc 92 8d 1a 8a aa f7 3e 48 fe  v..0....>H...
00b0 cb 88 ..

```

Sendo o MAC do router do DS: 00:11:22:33:44:55:66:77, temos que o AP fica com o DS anterior: bc:14:01:af:b1:98; e o MAC do *host* permanecem d8:a2:5e:71:41:a1.

15. O subtipo de tramas é *Acknowledgement*. A razão pela qual têm de existir é porque é um meio Wifi (e não Ethernet) suscetível a erros.

```

457 18.539... Apple_71:41:a1 HitronTe_af: 802.11 178 QoS Data, SN=1209, FN=0, Flags=p.....TC
458 18.540... Apple_71:41:a1 802.11 39 Acknowledgement, Flags=.....C
459 18.636... HitronTe_af:b1:98 Broadcast 802.11 296 Beacon frame, SN=2447, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
460 18.638... HitronTe_af:b1:99 Broadcast 802.11 205 Beacon frame, SN=2448, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon
461 18.739... HitronTe_af:b1:98 Broadcast 802.11 296 Beacon frame, SN=2449, FN=0, Flags=.....C, BI=100, SSID=FlyingNet
462 18.741... HitronTe_af:b1:99 Broadcast 802.11 205 Beacon frame, SN=2450, FN=0, Flags=.....C, BI=100, SSID=NOS_WIFI_Fon

<
> Frame 458: 39 bytes on wire (312 bits), 39 bytes captured (312 bits)
> Radiotap Header v0, Length 25
> 802.11 radio information
  IEEE 802.11 Acknowledgement, Flags: .....C
    Type/Subtype: Acknowledgement (0x001d)
      Frame Control Field: 0xd400
        ....00 = Version: 0
        ....01.. = Type: Control frame (1)
        1101 .... = Subtype: 13
        > Flags: 0x00
        .000 0000 0000 0000 = Duration: 0 microseconds
        Receiver address: Apple_71:41:a1 (d8:a2:5e:71:41:a1)
        Frame check sequence: 0x77a8823d [unverified]
        [FCS Status: Unverified]

0000 00 00 19 00 6f 08 00 00 40 0d 49 02 00 00 00 00  ....o...@I....
0010 10 02 a3 09 80 04 c4 a9 00 88 41 00 00 00 d8 a2 5e  .......A:....^
0020 71 41 a1 3d 82 a8 77 .. qA=-w

```

16. Sim está a ser usada a opção RTS/CTS, pois existe um compasso de espera característico desta opção.

```
▼ [Duration: 88µs]
    [Preamble: 20µs]
    [IFS: 39µs]
    [Start: 38338496µs]
    [End: 38338584µs]
```

Conclusão

Após a realização deste trabalho, o nosso grupo aprofundou os conhecimentos à cerca dos tópicos propostos, nomeadamente: o formato das tramas, o endereçamento dos componentes envolvidos na comunicação sem fios, os tipos de tramas mais comuns, bem como a operação do protocolo. Como tal adquirimos uma maior aptidão tanto a nível teórico como a nível prático. Com o auxílio do *Wireshark*, exploramos as diferentes matérias, referidas anteriormente, adquirindo os diversos conhecimentos de forma interativa. Desta forma, este trabalho prático promoveu uma experiência útil e enriquecedora que nos proporcionou uma melhor compreensão das matérias lecionadas.