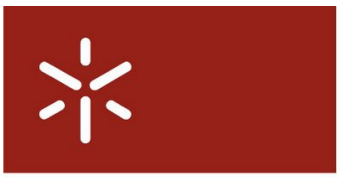


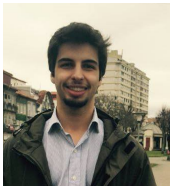
Universidade do Minho

# Relatório - Redes de Computadores

MIEI - 3º ano - 1º semestre
Universidade do Minho

## Redes sem fios (802.11)

## Grupo 58

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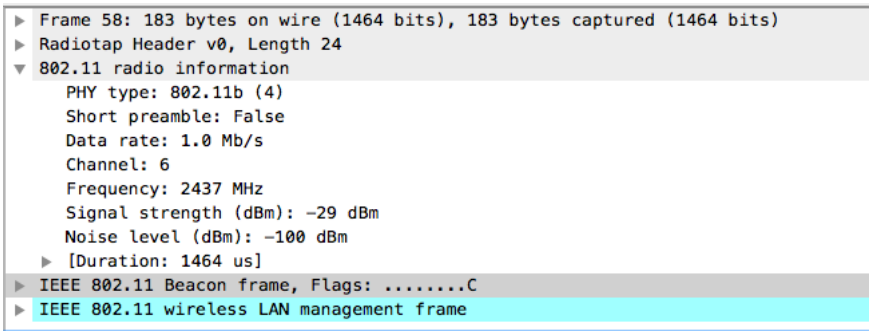
16 de Novembro de 2017

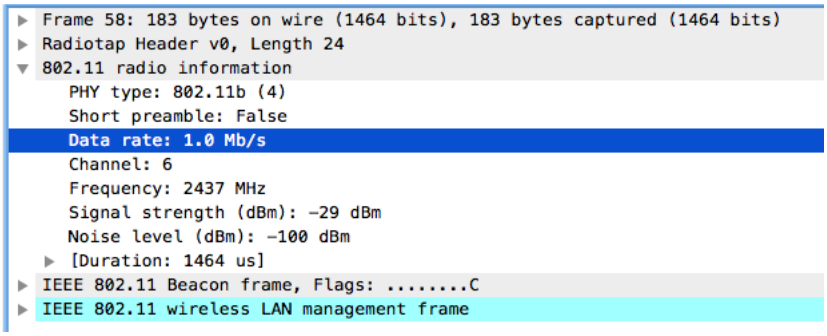
# 1. *Questões e Respostas*

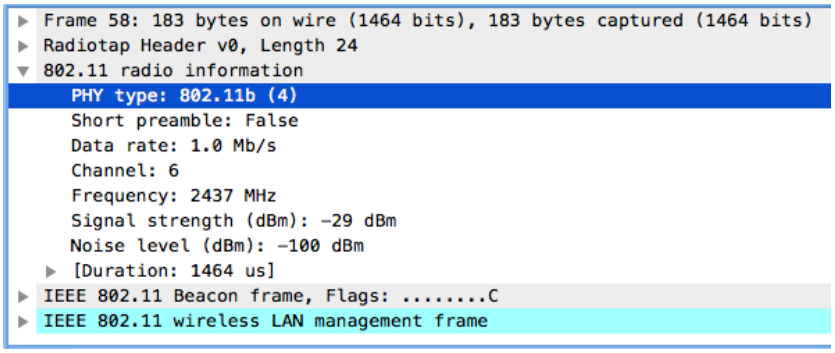
1. Identifique em que frequência do espectro está a operar a rede sem fios, e o canal corresponde essa frequência (pode confirmar com a norma IEEE 802.11).




A rede sem fios tem de frequência *2437 MHz*, o que corresponde ao canal 6, segundo a norma IEEE 802.11.

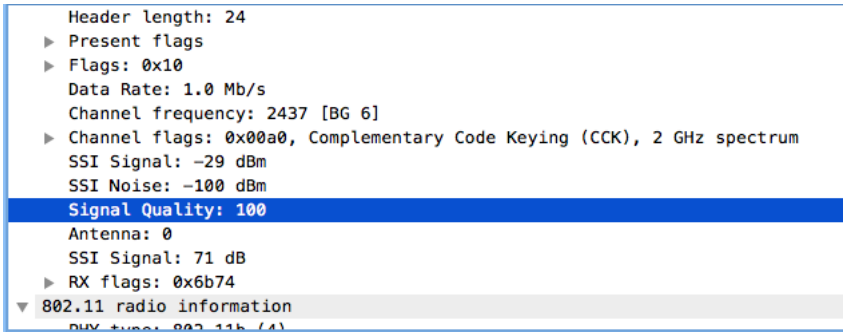
2. Qual o tipo do canal que está a ser usado para a comunicação rádio? Qual o débito a que foi enviada a trama escolhida?



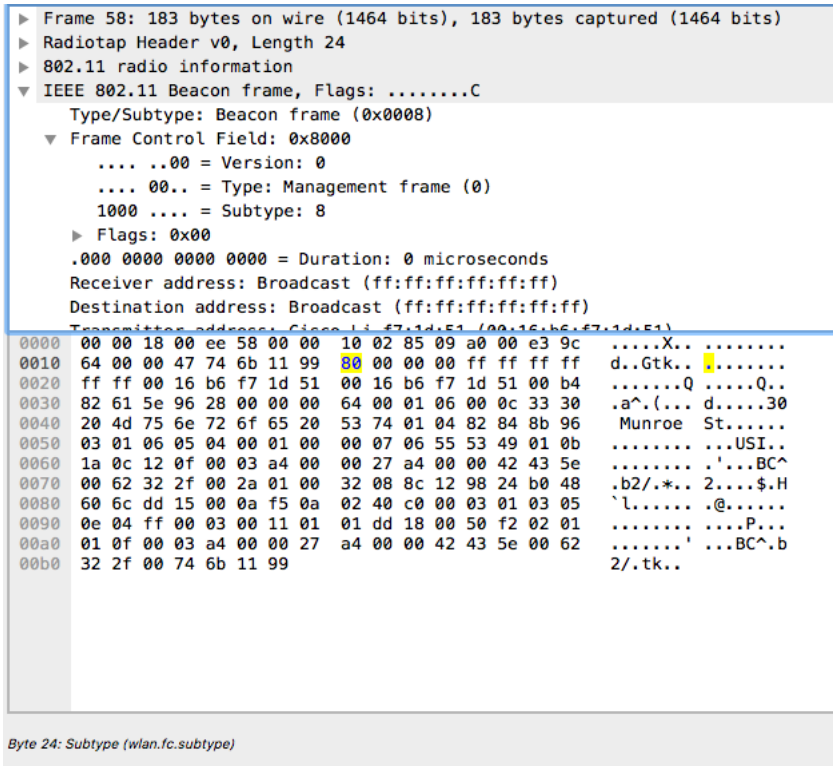
O tipo de canal que está a ser usado é *802.11b*, e a trama escolhida foi enviada a um débito de *1.0 Mb/s*.

3. Indique qual o índice de qualidade do sinal.




Tal como podemos observar no *printscreen* o índice da qualidade do sinal é 100.

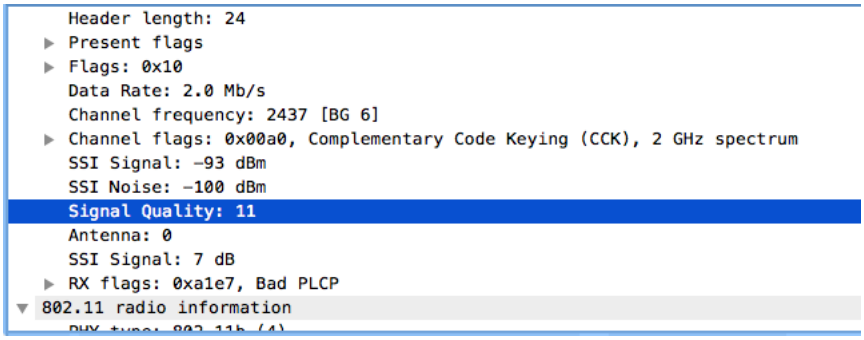
4. Qual o tipo de uma trama *beacon*? Indique quais os seus identificadores de tipo e subtipo. Em que parte da trama estão especificados?



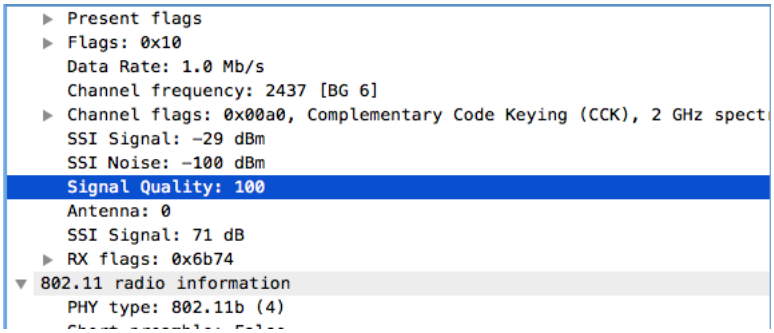

A correspondente trama *beacon* é uma trama de gestão, como podemos verificar pelo seu campo *Type: Management frame* (0x00) e com o subtipo 8 (0x1000). Podemos verificar no *printscreen* que a informação sobre estes campos se encontra no byte 24 da trama.

5. Identifique os SSIDs dos APs (*Acess Points*) que estão a operar na rede e diga qual tende a proporcionar a melhor qualidade de sinal?

```
32 1.314223   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2868, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
33 1.416593   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2869, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
34 1.420565   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3083, FN=0, Flags=........., BI=20580, SSID=linksys12
35 1.519009   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2870, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
36 1.621422   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2871, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
37 1.724031   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2872, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
38 1.826193   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2873, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
39 1.928599   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2874, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
40 2.030907   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2875, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
41 2.035064   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3089, FN=0, Flags=........., BI=100, SSID=linksys12
42 2.133342   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2876, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
43 2.137566   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3090, FN=0, Flags=........C, BI=100, SSID=linksys12
44 2.235695   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2877, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
57 2.338148   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2879, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
58 2.440572   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2880, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
60 2.542945   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2882, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
61 2.645319   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2883, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
```

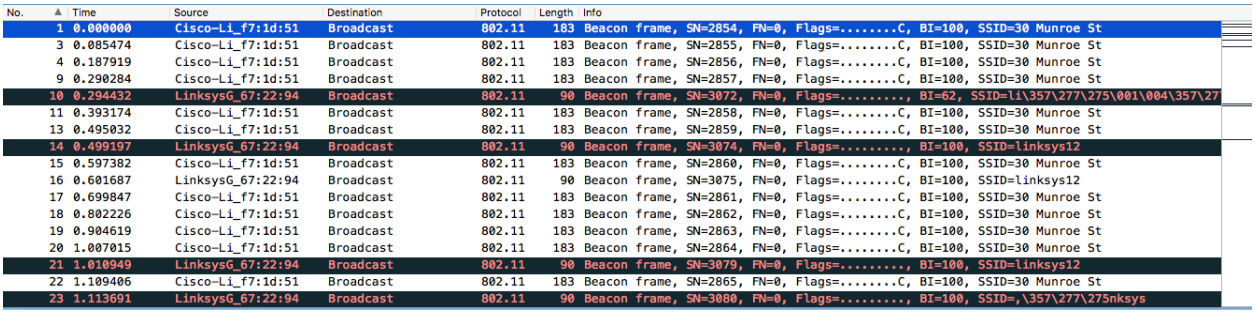



```
32 1.314223   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2868, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
33 1.416593   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2869, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
34 1.420565   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3083, FN=0, Flags=........., BI=20580, SSID=linksys12
35 1.519009   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2870, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
36 1.621422   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2871, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
37 1.724031   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2872, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
38 1.826193   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2873, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
39 1.928599   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2874, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
40 2.030907   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2875, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
41 2.035064   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3089, FN=0, Flags=........., BI=100, SSID=linksys12
42 2.133342   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2876, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
43 2.137566   LinksysG_67:22:94   Broadcast   802.11    90 Beacon frame, SN=3090, FN=0, Flags=........C, BI=100, SSID=linksys12
44 2.235695   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2877, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
57 2.338148   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2879, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
58 2.440572   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2880, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
60 2.542945   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2882, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
61 2.645319   Cisco-Li_f7:1d:51   Broadcast   802.11   183 Beacon frame, SN=2883, FN=0, Flags=........C, BI=100, SSID=30 Munroe St
```




Através dos *printscreen* apresentados podemos verificar a existência de dois APs que estão a operar na rede, em que o primeiro tem de SSID *linksys12* e o segundo *30 Munroe St*. Ao analisarmos as tramas de cada um destes APs, verificámos que enquanto no primeiro caso (*linksys12*) a qualidade de sinal é 11 e no segundo caso (*30 Munroe St*) é 100. Assim, concluímos que o AP correspondente ao segundo SSID tem melhor qualidade de sinal.

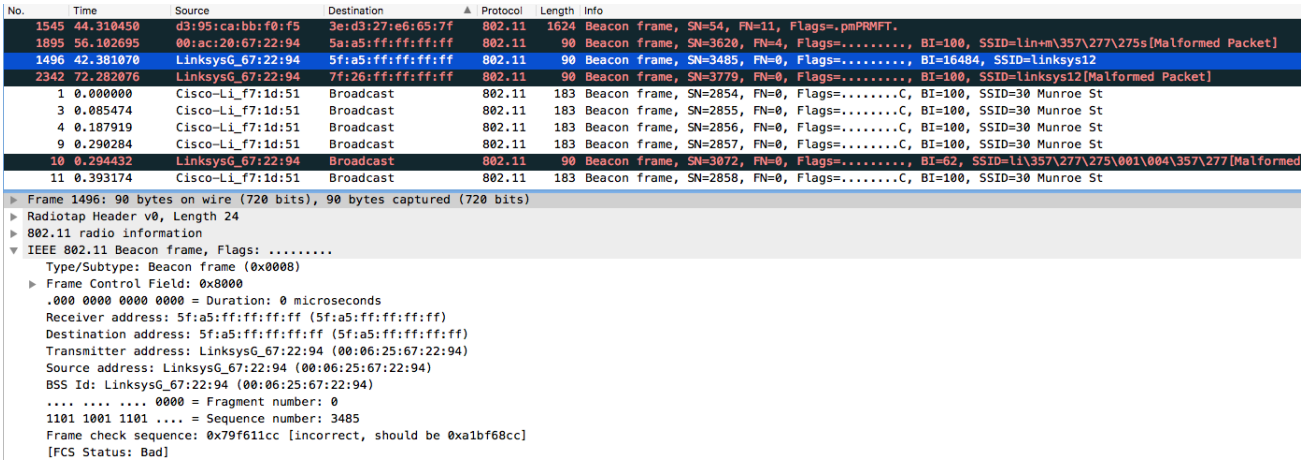
6. Para dois dos APs identificados, indique quais são os intervalos de tempo previstos entre as transmissões de tramas *beacon*? (nota: este valor é anunciado na própria trama *beacon*. Na prática, a periodicidade de tramas *beacon* é verificada? Tente explicar porquê.



| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1 | 0.000000 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2854, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 3 | 0.085474 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2855, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 4 | 0.187919 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2856, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 9 | 0.290284 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2857, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 10 | 0.294432 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3072, FN=0, Flags=....., BI=62, SSID=li\357\277\275\001\004\357\27 |
| 11 | 0.393174 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2858, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 13 | 0.495032 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2859, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 14 | 0.499197 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3074, FN=0, Flags=....., BI=100, SSID=linksys12 |
| 15 | 0.597382 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2860, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 16 | 0.601687 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3075, FN=0, Flags=.....C, BI=100, SSID=linksys12 |
| 17 | 0.699847 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2861, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 18 | 0.802226 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2862, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 19 | 0.904619 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2863, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 20 | 1.007015 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2864, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 21 | 1.010949 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3079, FN=0, Flags=....., BI=100, SSID=linksys12 |
| 22 | 1.109406 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2865, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 23 | 1.113691 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3080, FN=0, Flags=....., BI=100, SSID=,\357\277\275nksys |

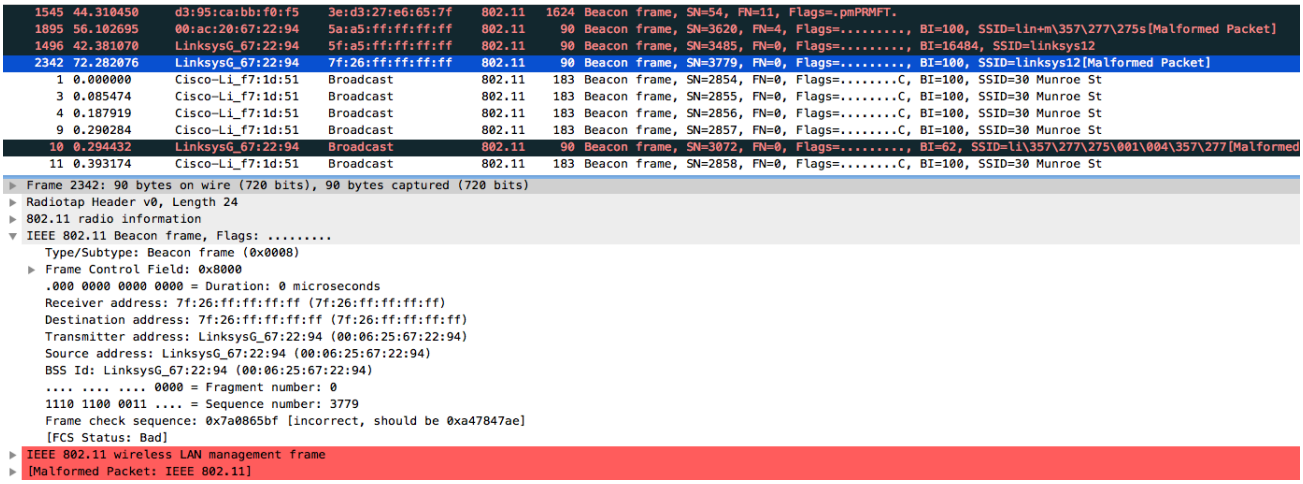
Tendo em conta a frequência de *2.4 GHz*, o intervalo de tempo entre cada trama deverá ser, aproximadamente, *0,102400 segundos*. No caso do AP *Cisco_Li_f7:1d:51*, e analisando as tramas 1 e 3, o intervalo de tempo é 0,085474. Considerámos este intervalo de tempo muito aproximado ao esperado, logo podemos verificar que a periodicidade das tramas é mantida. O mesmo não acontece no caso do AP *LinksysG_67:22:94*, em que ao analisar as tramas 10 e 14, reparamos que o intervalo de tempo é de *0,204765 segundos*, um valor muito distante do intervalo de tempo esperado.

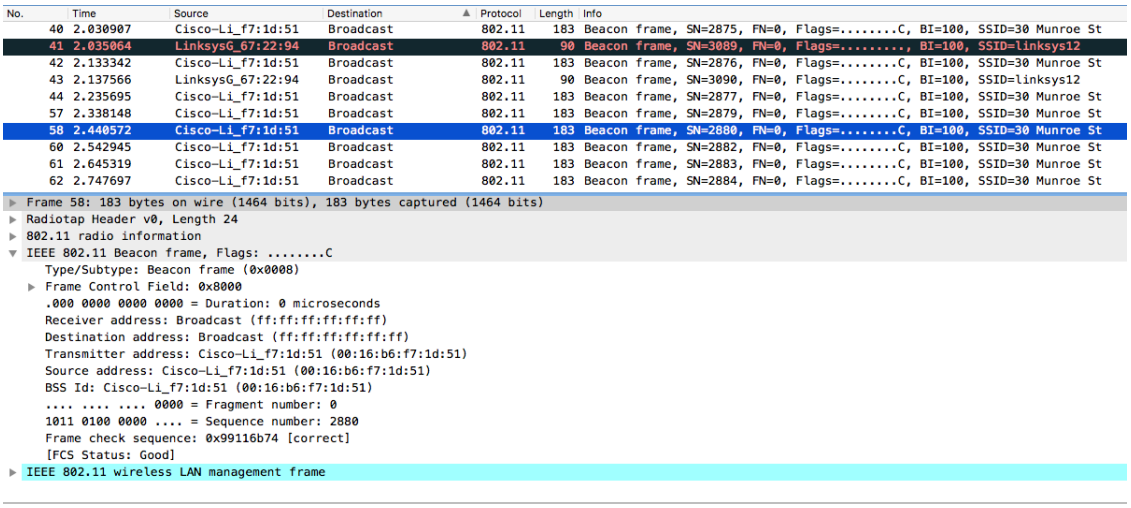
7. Identifique e registe todos os endereços MAC usados nas tramas *beacon* enviadas pelos APs. Recorde que fonte, destino e BSS ID são endereços contidos no cabeçalho das tramas 802.11. Para uma descrição detalhada da estrutura da trama 802.11, consulte o anexo ao enunciado.

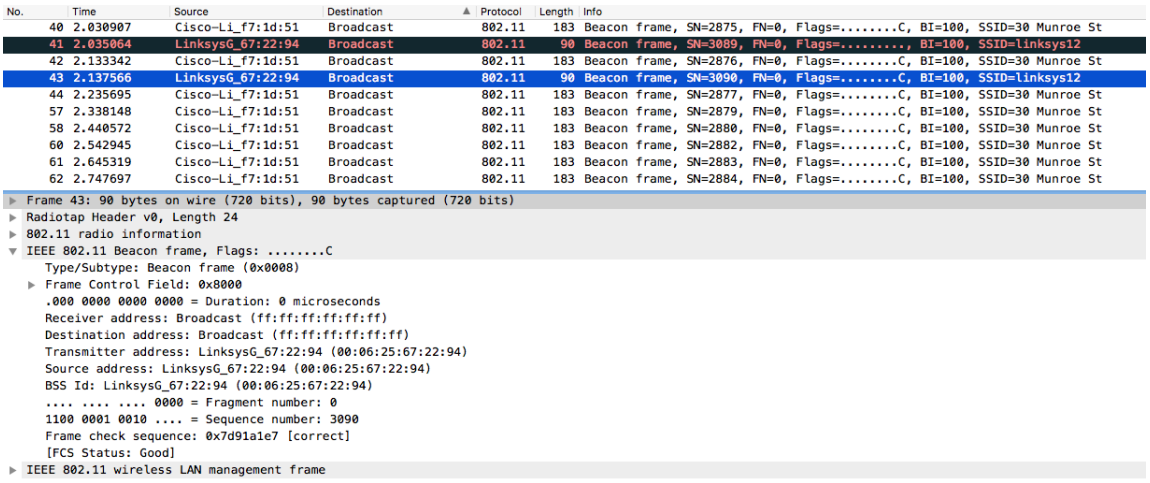


| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1545 | 44.310450 | d3:95:ca:bb:f0:f5 | 3e:d3:27:e6:65:7f | 802.11 | 1624 | Beacon frame, SN=54, FN=11, Flags=.pmPRMFT. |
| 1895 | 56.102695 | 00:ac:20:67:22:94 | 5a:a5:ff:ff:ff:ff | 802.11 | 90 | Beacon frame, SN=3620, FN=4, Flags=....., BI=100, SSID=lin+m\357\277\275s[Malformed Packet] |
| 1496 | 42.381070 | LinksysG_67:22:94 | 5f:a5:ff:ff:ff:ff | 802.11 | 90 | Beacon frame, SN=3485, FN=0, Flags=....., BI=16484, SSID=linksys12 |
| 2342 | 72.282076 | LinksysG_67:22:94 | 7f:26:ff:ff:ff:ff | 802.11 | 90 | Beacon frame, SN=3779, FN=0, Flags=....., BI=100, SSID=linksys12[Malformed Packet] |
| 1 | 0.000000 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2854, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 3 | 0.085474 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2855, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 4 | 0.187919 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2856, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 9 | 0.290284 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2857, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |
| 10 | 0.294432 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3072, FN=0, Flags=....., BI=62, SSID=li\357\277\275\001\004\357\277[Malformed |
| 11 | 0.393174 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2858, FN=0, Flags=.....C, BI=100, SSID=30 Munroe St |

```
▶ Frame 1496: 90 bytes on wire (720 bits), 90 bytes captured (720 bits)
▶ Radiotap Header v0, Length 24
▶ 802.11 radio information
▼ IEEE 802.11 Beacon frame, Flags: .........
    Type/Subtype: Beacon frame (0x0008)
  ▶ Frame Control Field: 0x8000
    .000 0000 0000 0000 = Duration: 0 microseconds
    Receiver address: 5f:a5:ff:ff:ff:ff (5f:a5:ff:ff:ff:ff)
    Destination address: 5f:a5:ff:ff:ff:ff (5f:a5:ff:ff:ff:ff)
    Transmitter address: LinksysG_67:22:94 (00:06:25:67:22:94)
    Source address: LinksysG_67:22:94 (00:06:25:67:22:94)
    BSS Id: LinksysG_67:22:94 (00:06:25:67:22:94)
    .... .... .... 0000 = Fragment number: 0
    1101 1001 1101 .... = Sequence number: 3485
    Frame check sequence: 0x79f611cc [incorrect, should be 0xa1bf68cc]
    [FCS Status: Bad]
```




Através dos *printscreens* em cima conseguimos identificar todos os endereços MAC usados nas correspondentes tramas, nos campos *Receiver address, Destination address, Transmitter address, Source address.*

8. As tramas *beacon* anunciam que o AP pode suportar vários débitos de base assim como vários *extended supported rates*. Indique quais são esses débitos?

```
        Tag Number: ERP Information (42)
        Tag length: 1
      ▶ ERP Information: 0x00
    ▼ Tag: Extended Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
        Tag Number: Extended Supported Rates (50)
        Tag length: 8
        Extended Supported Rates: 6(B) (0x8c)
        Extended Supported Rates: 9 (0x12)
        Extended Supported Rates: 12(B) (0x98)
        Extended Supported Rates: 18 (0x24)
        Extended Supported Rates: 24(B) (0xb0)
        Extended Supported Rates: 36 (0x48)
        Extended Supported Rates: 48 (0x60)
        Extended Supported Rates: 54 (0x6c)
    ▼ Tag: Vendor Specific: AirgoNet
        Tag Number: Vendor Specific (221)
        Tag length: 21
```

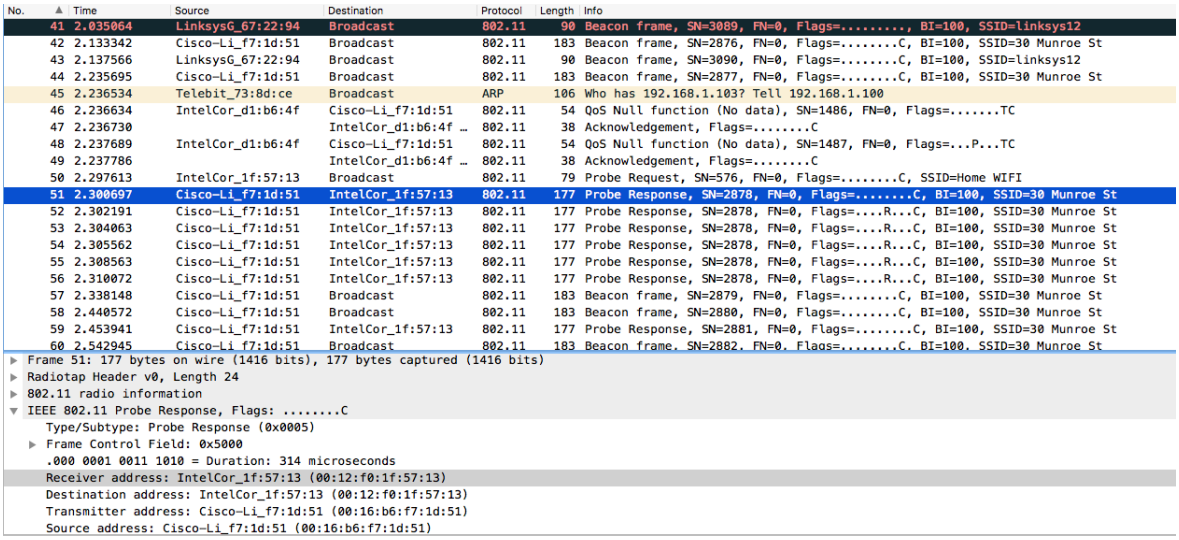
```
    ▼ Tag: SSID parameter set: linksys12
        Tag Number: SSID parameter set (0)
        Tag length: 9
        SSID: linksys12
    ▼ Tag: Supported Rates 1(B), 2(B), 5.5, 11, [Mbit/sec]
        Tag Number: Supported Rates (1)
        Tag length: 4
        Supported Rates: 1(B) (0x82)
        Supported Rates: 2(B) (0x84)
        Supported Rates: 5.5 (0x0b)
        Supported Rates: 11 (0x16)
    ▼ Tag: DS Parameter set: Current Channel: 6
        Tag Number: DS Parameter set (3)
        Tag length: 1
        Current Channel: 6
    ▼ Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap
        Tag Number: Traffic Indication Map (TIM) (5)
```

O AP com o SSID *30 Munroe St* suporta débitos até *54 Mbits/seg* que corresponde ao *802.11g*. Enquanto o outro só suporta débitos até *11 Mbits/seg*, ou seja, mantém-se pelo *802.11b*.

9. Indique a que sistemas são endereçadas estas tramas e qual o seu propósito?

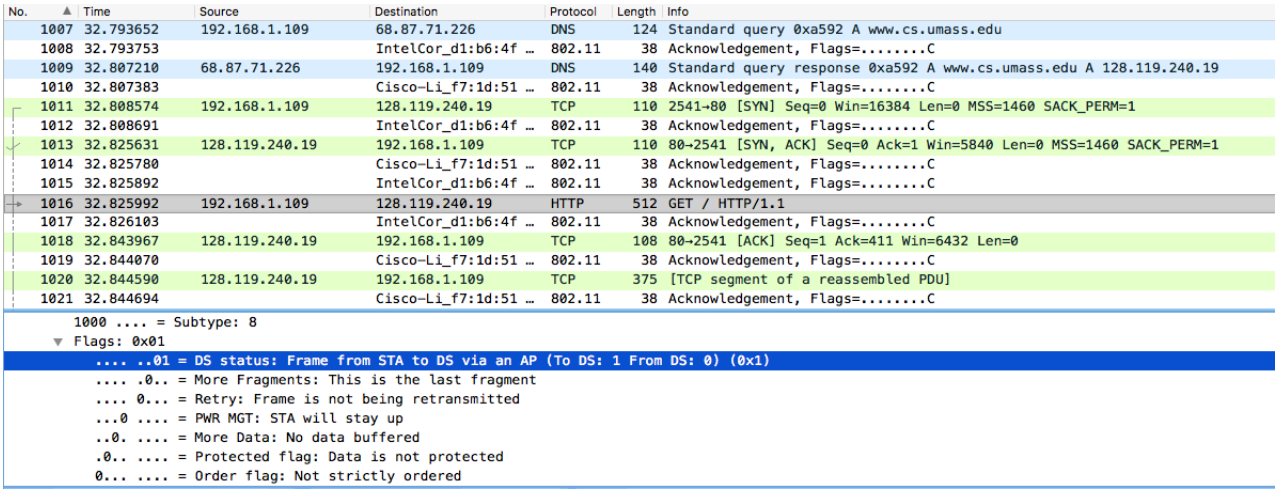
| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 41 | 2.035064 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3089, FN=0, Flags=........, BI=100, SSID=linksys12 |
| 42 | 2.133342 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2876, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 43 | 2.137566 | LinksysG_67:22:94 | Broadcast | 802.11 | 90 | Beacon frame, SN=3090, FN=0, Flags=........C, BI=100, SSID=linksys12 |
| 44 | 2.235695 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2877, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 45 | 2.236534 | Telebit_73:8d:ce | Broadcast | ARP | 106 | Who has 192.168.1.103? Tell 192.168.1.100 |
| 46 | 2.236634 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 54 | QoS Null function (No data), SN=1486, FN=0, Flags=.......TC |
| 47 | 2.236730 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 48 | 2.237689 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 54 | QoS Null function (No data), SN=1487, FN=0, Flags=...P...TC |
| 49 | 2.237786 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 50 | 2.297613 | IntelCor_1f:57:13 | Broadcast | 802.11 | 79 | Probe Request, SN=576, FN=0, Flags=........C, SSID=Home WIFI |
| 51 | 2.300697 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 52 | 2.302191 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=....R...C, BI=100, SSID=30 Munroe St |
| 53 | 2.304063 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=....R...C, BI=100, SSID=30 Munroe St |
| 54 | 2.305562 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=....R...C, BI=100, SSID=30 Munroe St |
| 55 | 2.308563 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=....R...C, BI=100, SSID=30 Munroe St |
| 56 | 2.310072 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2878, FN=0, Flags=....R...C, BI=100, SSID=30 Munroe St |
| 57 | 2.338148 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2879, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 58 | 2.440572 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2880, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 59 | 2.453941 | Cisco-Li_f7:1d:51 | IntelCor_1f:57:13 | 802.11 | 177 | Probe Response, SN=2881, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 60 | 2.542945 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=2882, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |

```
▶ Frame 50: 79 bytes on wire (632 bits), 79 bytes captured (632 bits)
▶ Radiotap Header v0, Length 24
▶ 802.11 radio information
▼ IEEE 802.11 Probe Request, Flags: ........C
    Type/Subtype: Probe Request (0x0004)
  ▶ Frame Control Field: 0x4000
    .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: IntelCor_1f:57:13 (00:12:f0:1f:57:13)
    Source address: IntelCor_1f:57:13 (00:12:f0:1f:57:13)
```

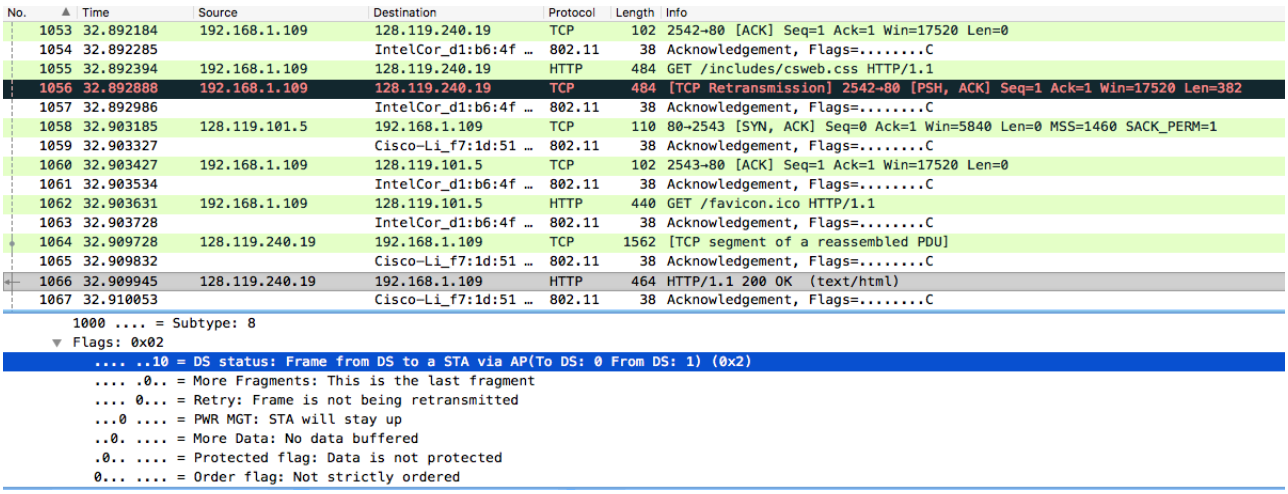



A trama referente ao probe request, tem origem origem num *STA (00:12:f0:1f:57:13)*. A STA envia uma trama Probe Request quando precisa obter informações de uma outra estação. Desta forma, esta trama torna-se útil para uma STA determinar quais os APs que estão dentro do seu alcance rádio (active scanning), isto é, ao enviar a trama Probe Request em broadcast, as APs dentro do seu alcance vão responder com uma trama Probe Response, que contém informações sobre as taxas de dados suportadas, etc. Neste caso a AP com endereço *00:16:b6:f7:1d:51*, foi a que respondeu.

10. O campo *Frame Control* contido no cabeçalho das tramas 802.11 permite especificar a direccionalidade das tramas. Identifique a direccionalidade das tramas indicadas acima (nº1016 e nº1066). Este aspecto é fundamental para entender o endereçamento MAC em redes sem fios.

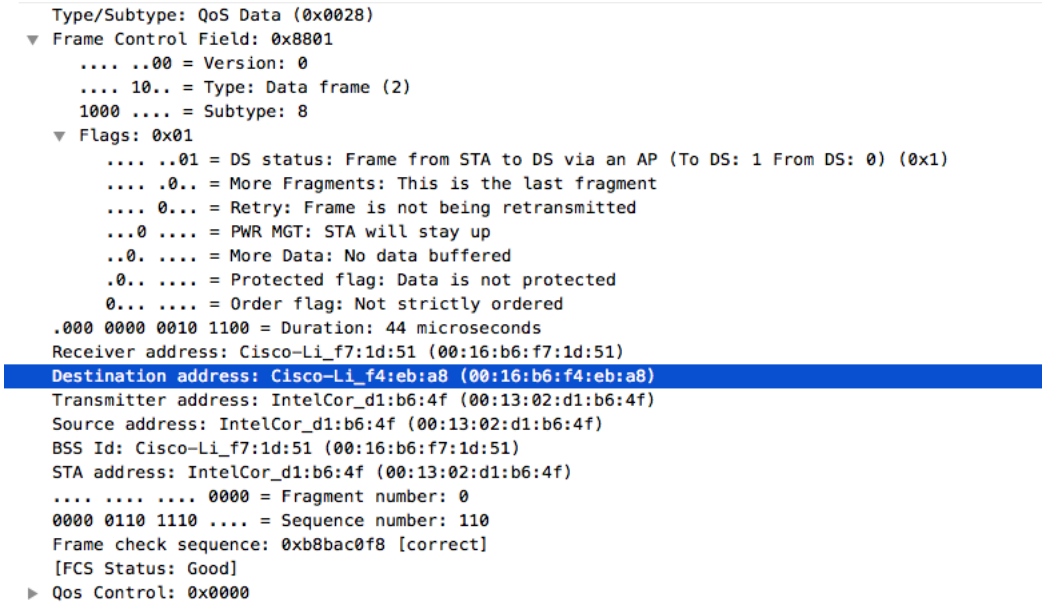



Nesta trama a direcionalidade é *To DS: 1 From DS: 0*, logo o sender/transmiter é um MAC STA (*IntelCor_d1:b6:4f*), o receiver é um MAC AP (*Cisco-Li_f7:1d:51*) e o destination é um MAC Router (*Cisco-Li_f4:eb:a8*).




Nesta trama a direcionalidade é *To DS: 0 From DS: 1*, logo o sender é um MAC Router (*Cisco-Li_f4:eb:a8*), o transmiter é um MAC AP (*Cisco-Li_f7:1d:51*) e o destination/receiver é um MAC STA (*IntelCor_d1:b6:4f*).

11. Para a trama 802.11 que contém o pedido GET, indique os três endereços MAC em uso, identificando qual o endereço MAC correspondente ao *host* sem fios, ao AP e ao router de acesso ao sistema de distribuição (DS)?




Os endereços MAC em uso são os seguintes:
Host sem fios - 00:13:02:d1:b6:4f *(transmitter)*
AP - 00:16:b6:f7:1d:51 *(receiver)*
Router - 00:16:b6:f4:eb:a8 *(destination)*

12. Para a trama 802.11 que contém a resposta ao pedido GET, indique e identifique quais os três endereços MAC em uso?

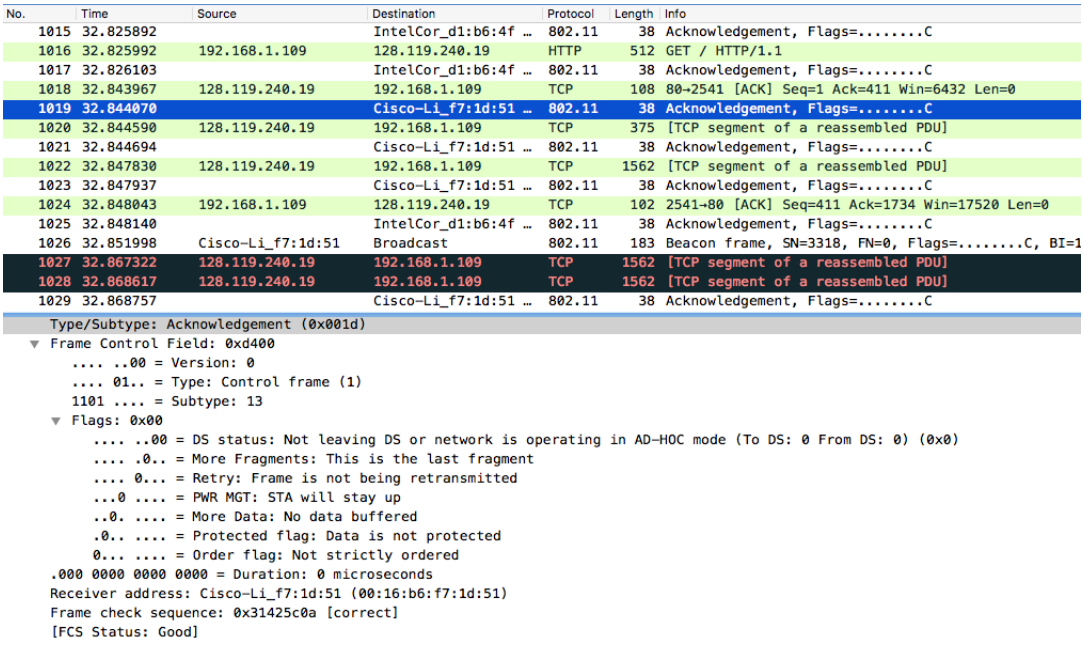
```
▼ Frame Control Field: 0x8802
    .... ..00 = Version: 0
    .... 10.. = Type: Data frame (2)
    1000 .... = Subtype: 8
  ▼ Flags: 0x02
      .... ..10 = DS status: Frame from DS to a STA via AP(To DS: 0 From DS: 1) (0x2)
      .... .0.. = More Fragments: This is the last fragment
      .... 0... = 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
  .000 0000 0010 1000 = Duration: 40 microseconds
  Receiver address: IntelCor_d1:b6:4f (00:13:02:d1:b6:4f)
  Destination address: IntelCor_d1:b6:4f (00:13:02:d1:b6:4f)
  Transmitter address: Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51)
  Source address: Cisco-Li_f4:eb:a8 (00:16:b6:f4:eb:a8)
  BSS Id: Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51)
```

Os endereços MAC em uso são os seguintes:
Host sem fios - 00:13:02:d1:b6:4f *(receiver/destination)*
AP - 00:16:b6:f7:1d:51 *(transmitter)*
Router - 00:16:b6:f4:eb:a8 *(source)*

13. Que subtipo de tramas de controlo são transmitidas ao longo da interação acima mencionada? Verifique a que sistemas são endereçadas. Tente explicar proque razão têm de existir (contrariamente ao que acontece numa rede Ethernet.).

| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1015 | 32.825892 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1016 | 32.825992 | 192.168.1.109 | 128.119.240.19 | HTTP | 512 | GET / HTTP/1.1 |
| 1017 | 32.826103 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1018 | 32.843967 | 128.119.240.19 | 192.168.1.109 | TCP | 108 | 80→2541 [ACK] Seq=1 Ack=411 Win=6432 Len=0 |
| 1019 | 32.844070 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1020 | 32.844590 | 128.119.240.19 | 192.168.1.109 | TCP | 375 | [TCP segment of a reassembled PDU] |
| 1021 | 32.844694 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1022 | 32.847830 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1023 | 32.847937 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1024 | 32.848043 | 192.168.1.109 | 128.119.240.19 | TCP | 102 | 2541→80 [ACK] Seq=411 Ack=1734 Win=17520 Len=0 |
| 1025 | 32.848140 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1026 | 32.851998 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3318, FN=0, Flags=........C, E |
| 1027 | 32.867322 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1028 | 32.868617 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1029 | 32.868757 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |

```
  Type/Subtype: Acknowledgement (0x001d)
▼ Frame Control Field: 0xd400
    .... ..00 = Version: 0
    .... 01.. = Type: Control frame (1)
    1101 .... = Subtype: 13
  ▼ 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
  .000 0000 0000 0100 = Duration: 4 microseconds
  Receiver address: IntelCor_d1:b6:4f (00:13:02:d1:b6:4f)
  Frame check sequence: 0x64c4665e [correct]
  [FCS Status: Good]
```

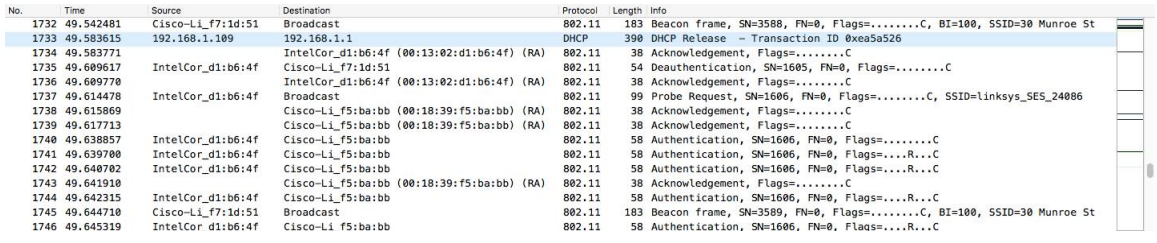


| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1015 | 32.825892 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1016 | 32.825992 | 192.168.1.109 | 128.119.240.19 | HTTP | 512 | GET / HTTP/1.1 |
| 1017 | 32.826103 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1018 | 32.843967 | 128.119.240.19 | 192.168.1.109 | TCP | 108 | 80→2541 [ACK] Seq=1 Ack=411 Win=6432 Len=0 |
| 1019 | 32.844070 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1020 | 32.844590 | 128.119.240.19 | 192.168.1.109 | TCP | 375 | [TCP segment of a reassembled PDU] |
| 1021 | 32.844694 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1022 | 32.847830 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1023 | 32.847937 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1024 | 32.848043 | 192.168.1.109 | 128.119.240.19 | TCP | 102 | 2541→80 [ACK] Seq=411 Ack=1734 Win=17520 Len=0 |
| 1025 | 32.848140 | | IntelCor_d1:b6:4f … | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1026 | 32.851998 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3318, FN=0, Flags=........C, BI=1 |
| 1027 | 32.867322 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1028 | 32.868617 | 128.119.240.19 | 192.168.1.109 | TCP | 1562 | [TCP segment of a reassembled PDU] |
| 1029 | 32.868757 | | Cisco-Li_f7:1d:51 … | 802.11 | 38 | Acknowledgement, Flags=........C |

```
Type/Subtype: Acknowledgement (0x001d)
▼ Frame Control Field: 0xd400
    .... ..00 = Version: 0
    .... 01.. = Type: Control frame (1)
    1101 .... = Subtype: 13
  ▼ 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
  .000 0000 0000 0000 = Duration: 0 microseconds
  Receiver address: Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51)
  Frame check sequence: 0x31425c0a [correct]
  [FCS Status: Good]
```

O subtipo das tramas de controlo que são transmitidas ao longo da iteração acima mencionada é *Acknowlegement*. Depois de receber uma trama de dados, a STA receptora irá utilizar um código de verificação para detectar a presença de erros, e envia uma trama ACK para a STA emissora, se não forem encontrados erros. Se a STA emissora não receber um ACK dentro de um determinado período de tempo, retransmite a trama. Os sistemas endereçados são o AP e o STA.

14. Identifique e interprete as tramas 802.11 enviadas pelo *host* decorrentes do pedido *DHCP Release* que determina a quebra de associação que existia com o AP 30 Munroe St. Segundo a norma IEEE 802.11, há alguma trama que seria esperada, mas não aparece?

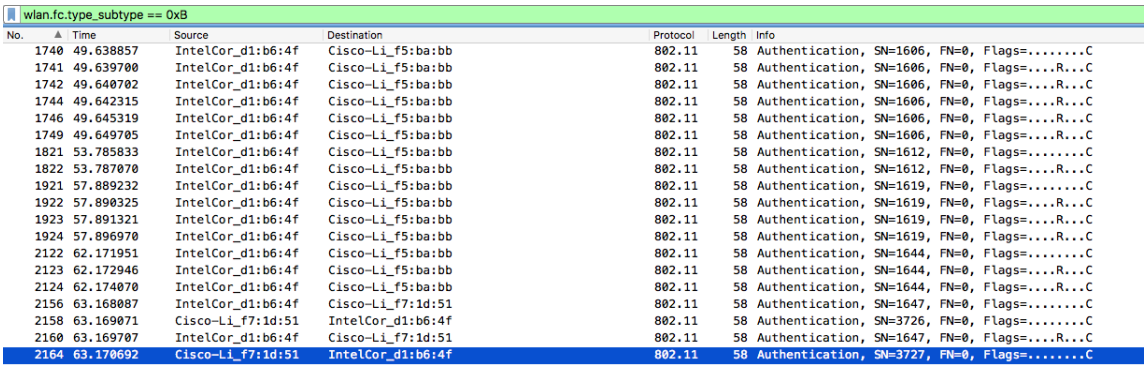


| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1732 | 49.542481 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3588, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 1733 | 49.583615 | 192.168.1.109 | 192.168.1.1 | DHCP | 390 | DHCP Release - Transaction ID 0xea5a526 |
| 1734 | 49.583771 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1735 | 49.609617 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 54 | Deauthentication, SN=1605, FN=0, Flags=........C |
| 1736 | 49.609770 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1737 | 49.614478 | IntelCor_d1:b6:4f | Broadcast | 802.11 | 99 | Probe Request, SN=1606, FN=0, Flags=........C, SSID=linksys_SES_24086 |
| 1738 | 49.615869 | | Cisco-Li_f5:ba:bb (00:18:39:f5:ba:bb) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1739 | 49.617713 | | Cisco-Li_f5:ba:bb (00:18:39:f5:ba:bb) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1740 | 49.638857 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=........C |
| 1741 | 49.639700 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1742 | 49.640702 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1743 | 49.641910 | | Cisco-Li_f5:ba:bb (00:18:39:f5:ba:bb) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 1744 | 49.642315 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1745 | 49.644710 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3589, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 1746 | 49.645319 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |

As tramas enviadas pelo host, decorrentes do pedido *DHCP Release* que determinam a quebra de associação que existia com o AP 30 Munroe St são as tramas que se seguem à trama 1733 (trama do pedido DHCP), isto é, as tramas *Acknowledgement*, *Deauthentication* (responsáveis pela desautenticação), seguidas das tramas *Acknowledgment*, *Probe Request* e *Authentication* (responsáveis pela tentativa de autenticação). A trama que seria esperada mas não aparece é a trama de *Dissociation*.

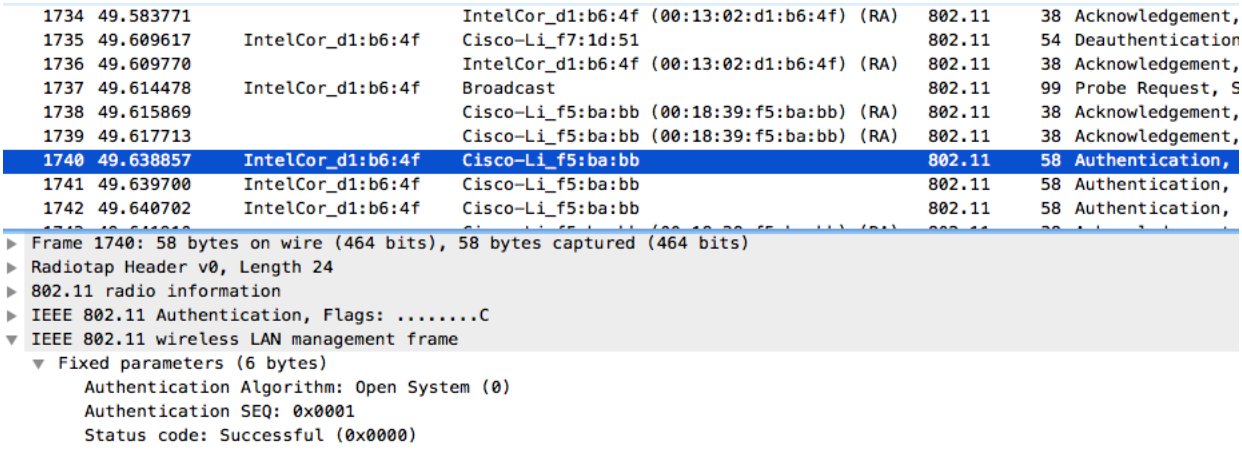
15. Examine o ficheiro de trace e procure tramas de autenticação enviadas pelo

*host* para o AP (se filtrar os resultados por *wlan.fc.type_subtype* ajuda a localização). Quantas tramas de *authentication* são enviadas do *host* sem fios para o AP linksys_SES_24086?



wlan.fc.type_subtype == 0xB

| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 1740 | 49.638857 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=........C |
| 1741 | 49.639700 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1742 | 49.640702 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1744 | 49.642315 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1746 | 49.645319 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1749 | 49.649705 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1606, FN=0, Flags=....R...C |
| 1821 | 53.785833 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1612, FN=0, Flags=........C |
| 1822 | 53.787070 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1612, FN=0, Flags=....R...C |
| 1921 | 57.889232 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1619, FN=0, Flags=........C |
| 1922 | 57.890325 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1619, FN=0, Flags=....R...C |
| 1923 | 57.891321 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1619, FN=0, Flags=....R...C |
| 1924 | 57.896970 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1619, FN=0, Flags=....R...C |
| 2122 | 62.171951 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1644, FN=0, Flags=........C |
| 2123 | 62.172946 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1644, FN=0, Flags=....R...C |
| 2124 | 62.174070 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, SN=1644, FN=0, Flags=....R...C |
| 2156 | 63.168087 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 58 | Authentication, SN=1647, FN=0, Flags=........C |
| 2158 | 63.169071 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 58 | Authentication, SN=3726, FN=0, Flags=........C |
| 2160 | 63.169707 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 58 | Authentication, SN=1647, FN=0, Flags=....R...C |
| 2164 | 63.170692 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 58 | Authentication, SN=3727, FN=0, Flags=........C |

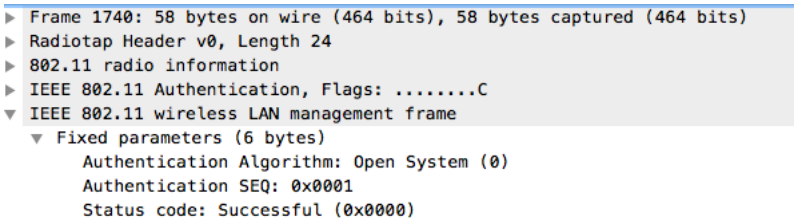


| | | | | | | |
|---|---|---|---|---|---|---|
| 1734 | 49.583771 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, |
| 1735 | 49.609617 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 54 | Deauthentication |
| 1736 | 49.609770 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, |
| 1737 | 49.614478 | IntelCor_d1:b6:4f | Broadcast | 802.11 | 99 | Probe Request, S |
| 1738 | 49.615869 | | Cisco-Li_f5:ba:bb (00:18:39:f5:ba:bb) (RA) | 802.11 | 38 | Acknowledgement, |
| 1739 | 49.617713 | | Cisco-Li_f5:ba:bb (00:18:39:f5:ba:bb) (RA) | 802.11 | 38 | Acknowledgement, |
| 1740 | 49.638857 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, |
| 1741 | 49.639700 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, |
| 1742 | 49.640702 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 58 | Authentication, |

```
▶ Frame 1740: 58 bytes on wire (464 bits), 58 bytes captured (464 bits)
▶ Radiotap Header v0, Length 24
▶ 802.11 radio information
▶ IEEE 802.11 Authentication, Flags: ........C
▼ IEEE 802.11 wireless LAN management frame
  ▼ Fixed parameters (6 bytes)
      Authentication Algorithm: Open System (0)
      Authentication SEQ: 0x0001
      Status code: Successful (0x0000)
```

Pela observação dos *printscreens* podemos verificar que são enviadas 15 tramas de *authentication* para o AP *linksys_SES_24086* que tem o endereço MAC *Cisco-Li_f7:1d:51*.

16. O *host* tenta usar algum algoritmo de autenticação/chave ou tenta aceder de forma aberta (consulte o *authentication algorithm* na trama)? Existe alguma resposta do AP linksys_SES_24086 ao pedido de autenticação? Porquê?



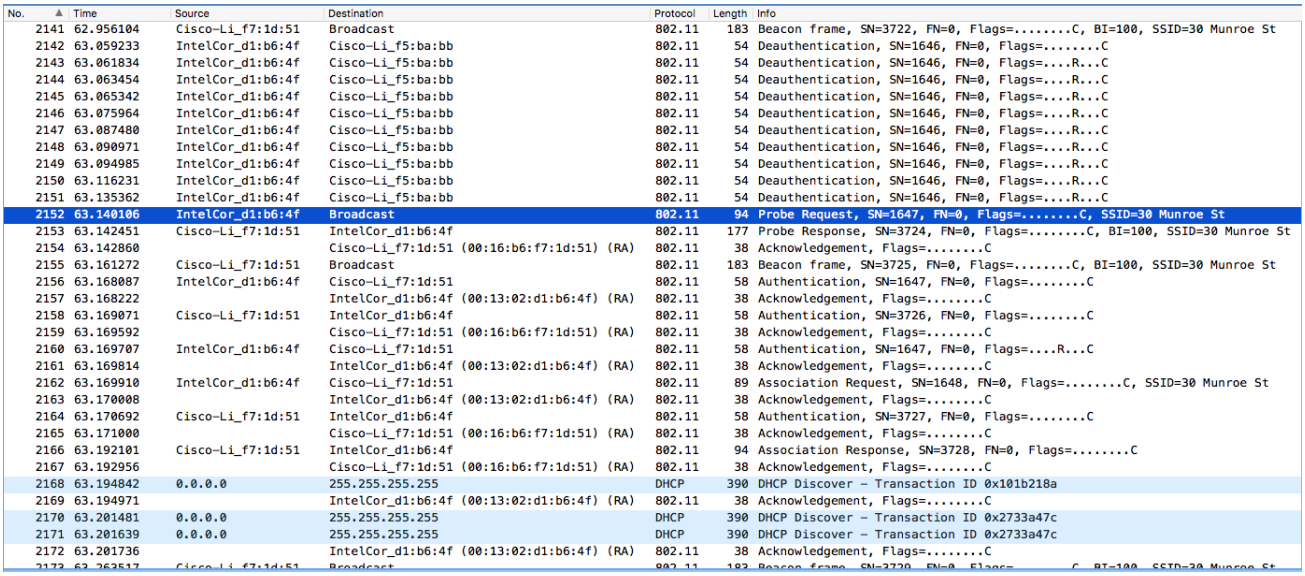
```
▶ Frame 1740: 58 bytes on wire (464 bits), 58 bytes captured (464 bits)
▶ Radiotap Header v0, Length 24
▶ 802.11 radio information
▶ IEEE 802.11 Authentication, Flags: ........C
▼ IEEE 802.11 wireless LAN management frame
  ▼ Fixed parameters (6 bytes)
      Authentication Algorithm: Open System (0)
      Authentication SEQ: 0x0001
      Status code: Successful (0x0000)
```

---

O algoritmo usado pelo host na autenticação é o *open system*. Não existe

resposta por parte do AP, pois trata-se de uma tentativa de autenticação de forma aberta, isto é, sem chave. No entanto, a chave deveria ser necessária.

17. Verifique que, após a tentativa de associação falhada, o *host* volta a associar-se ao AP 30 Munroe St. Identifique as tramas usadas para o efeito.



| No. | Time | Source | Destination | Protocol | Length | Info |
|---|---|---|---|---|---|---|
| 2141 | 62.956104 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3722, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 2142 | 63.059233 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=........C |
| 2143 | 63.061834 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2144 | 63.063454 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2145 | 63.065342 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2146 | 63.075964 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2147 | 63.087480 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2148 | 63.090971 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2149 | 63.094985 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2150 | 63.116231 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2151 | 63.135362 | IntelCor_d1:b6:4f | Cisco-Li_f5:ba:bb | 802.11 | 54 | Deauthentication, SN=1646, FN=0, Flags=....R...C |
| 2152 | 63.140106 | IntelCor_d1:b6:4f | Broadcast | 802.11 | 94 | Probe Request, SN=1647, FN=0, Flags=........C, SSID=30 Munroe St |
| 2153 | 63.142451 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 177 | Probe Response, SN=3724, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 2154 | 63.142860 | | Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2155 | 63.161272 | Cisco-Li_f7:1d:51 | Broadcast | 802.11 | 183 | Beacon frame, SN=3725, FN=0, Flags=........C, BI=100, SSID=30 Munroe St |
| 2156 | 63.168087 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 58 | Authentication, SN=1647, FN=0, Flags=........C |
| 2157 | 63.168222 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2158 | 63.169071 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 58 | Authentication, SN=3726, FN=0, Flags=........C |
| 2159 | 63.169592 | | Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2160 | 63.169707 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 58 | Authentication, SN=1647, FN=0, Flags=....R...C |
| 2161 | 63.169814 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2162 | 63.169910 | IntelCor_d1:b6:4f | Cisco-Li_f7:1d:51 | 802.11 | 89 | Association Request, SN=1648, FN=0, Flags=........C, SSID=30 Munroe St |
| 2163 | 63.170008 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2164 | 63.170692 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 58 | Authentication, SN=3727, FN=0, Flags=........C |
| 2165 | 63.171000 | | Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2166 | 63.192101 | Cisco-Li_f7:1d:51 | IntelCor_d1:b6:4f | 802.11 | 94 | Association Response, SN=3728, FN=0, Flags=........C |
| 2167 | 63.192956 | | Cisco-Li_f7:1d:51 (00:16:b6:f7:1d:51) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2168 | 63.194842 | 0.0.0.0 | 255.255.255.255 | DHCP | 390 | DHCP Discover - Transaction ID 0x101b218a |
| 2169 | 63.194971 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |
| 2170 | 63.201481 | 0.0.0.0 | 255.255.255.255 | DHCP | 390 | DHCP Discover - Transaction ID 0x2733a47c |
| 2171 | 63.201639 | 0.0.0.0 | 255.255.255.255 | DHCP | 390 | DHCP Discover - Transaction ID 0x2733a47c |
| 2172 | 63.201736 | | IntelCor_d1:b6:4f (00:13:02:d1:b6:4f) (RA) | 802.11 | 38 | Acknowledgement, Flags=........C |

As tramas utilizadas para o efeito, são as tramas compreendidas entre os números 2152 e 2168. Após a tentativa de autenticação consegue um *Association Response*, ficando assim conetado ao AP.

# 2. *Conclusão*

Após a realiazação deste trabalho prático podemos afirmar que ficamos bastante mais esclarecidos relativamente ao protocolo IEEE 802.11, tanto ao nível do formato das tramas que o constituiem, como ao nível do endereçamento dos componentes que fazem parte da comunicação sem fios. Relativamente às tramas, ficamos a saber que estas se dividem em três tipos, as Tramas de Gestão, responsáveis por estabelecer e manter a comunicação entre as STAs, as Tramas de Controlo, responsáveis por ajudar na troca de tramas de dados entre as STAs, e as Tramas de Dados que são responsáveis pela transmissão e comunicação de dados.