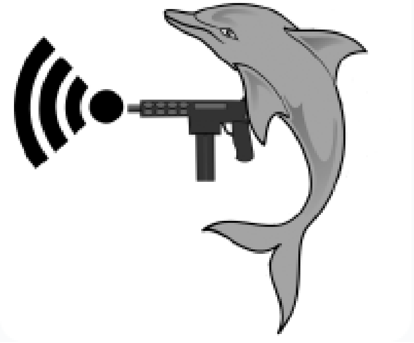
Dissecting the Encryption Protocols Inside Apple AirTags

By Christine Fossaceca

AirTag • Designed by Apple in California • Assembled in China
Bluetooth LE • Ultra Wideband



$whoami

```
/home/christine $ c
```

@x71n3

her hax
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my dog Honey(pot)

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Agenda

- Last year: (lightning review)
  - What is the Continuity Protocol?
  - How to Capture Continuity Data
  - Packet Breakdown
- This year:
  - FindMy Protocol
  - AirTag Packet Breakdown
  - AirTag Encryption

Continuity Protocol RECAP

It’s not a bug, it’s a feature!

- ”Continuity” allows for information sharing and “seamless” experience” across Apple products and peripherals
  - Examples: Resume browsing from iPhone to MacBook, Universal Clipboard, Instant Hotspot, WiFi Password

- Powered via a combination of Wi-Fi and Bluetooth LE

- Proprietary! But we have reverse engineered this protocol and disclosed to Apple where Continuity exposes sensitive information or is poorly implemented**. Shmoocon 2020. Objective By the Sea 2022. Jailbreak Security Summit 2022.**
- Past @furiousmac Papers: **Handoff All Your Privacy – A Review of Apple’s Bluetooth Low Energy Continuity Protocol; Who Tracks the Trackers? Circumventing Apple’s Anti-Tracking Alerts in the Find My Network;**
- Other research: Discontinued Privacy: Personal Data Leaks in Apple Bluetooth-Low-Energy Continuity Protocols; TU Darmstadt (multiple works) such as Open Haystack and AirGuard

Continuity Protocol Explained

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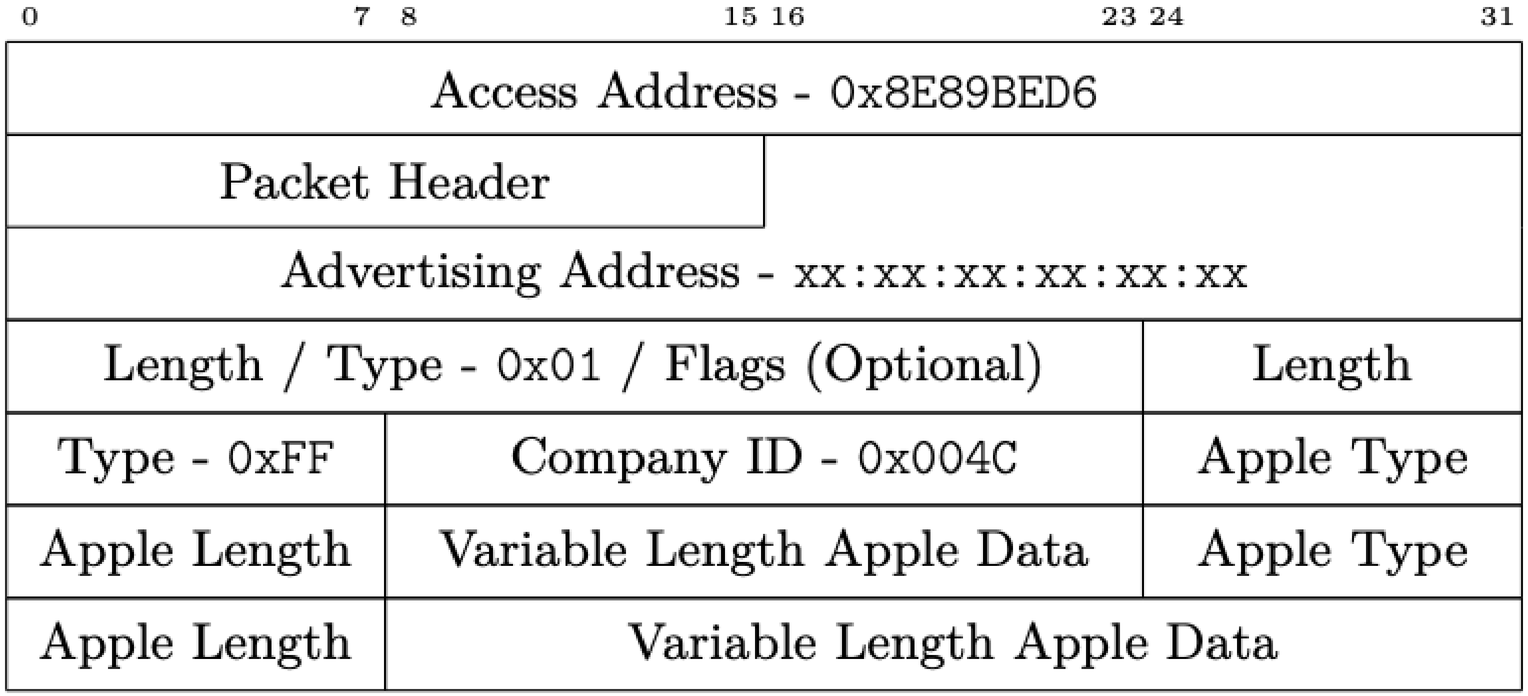

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Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

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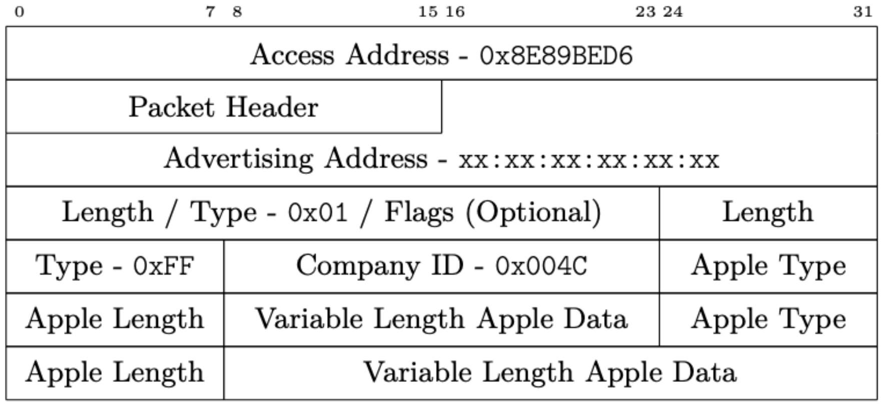

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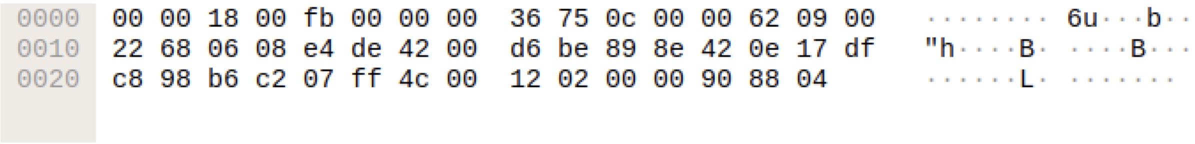

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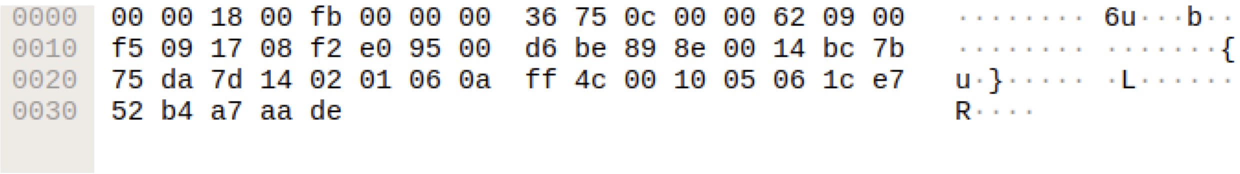
0010  22 68 06 08 e4 de 42 00  d6 be 89 8e 42 0e 17 df   "h····B· ····B···
0020  c8 98 b6 c2 07 ff 4c 00  12 02 00 00 90 88 04      ······L· ·······
```



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0010  f5 09 17 08 f2 e0 95 00  d6 be 89 8e 00 14 bc 7b   ········ ·······{
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0030  52 b4 a7 aa de                                     R····
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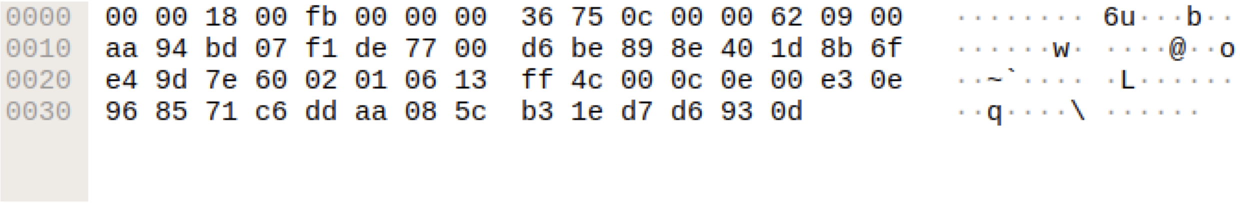

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0020  e4 9d 7e 60 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e   ··~`···· ·L······
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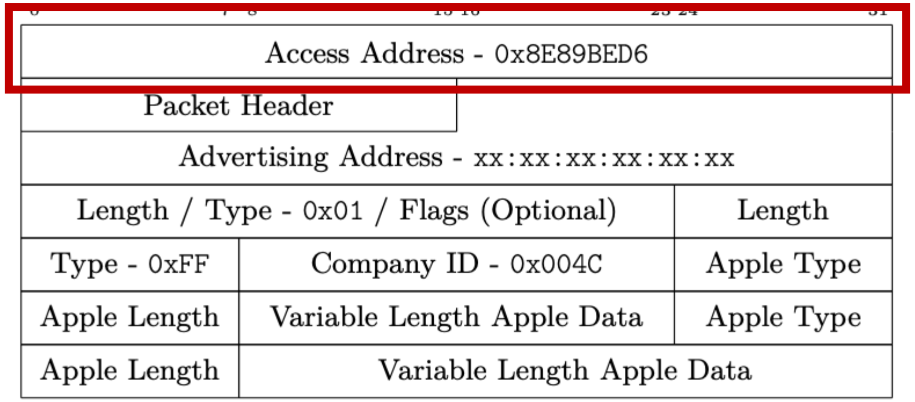

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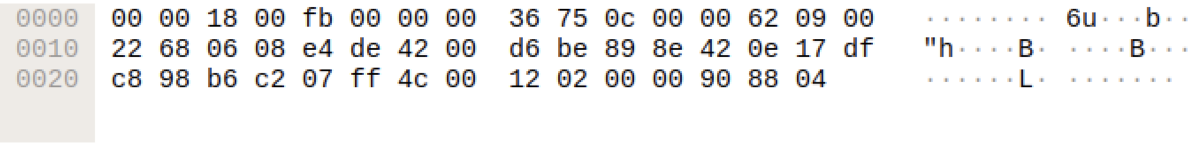

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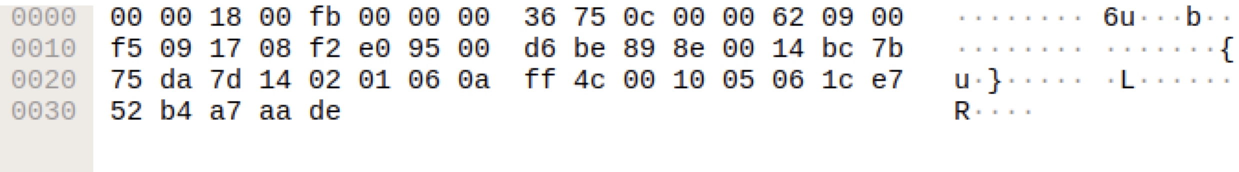

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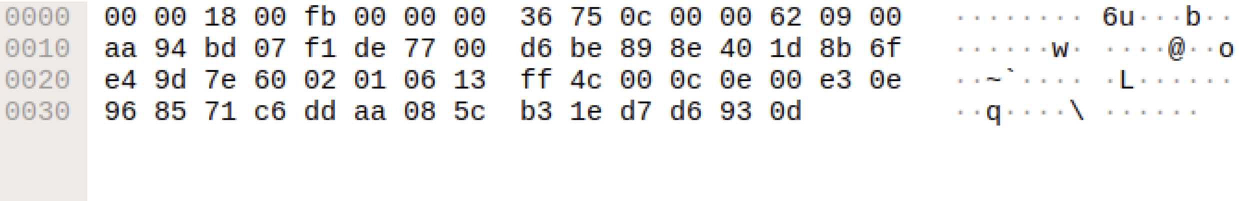

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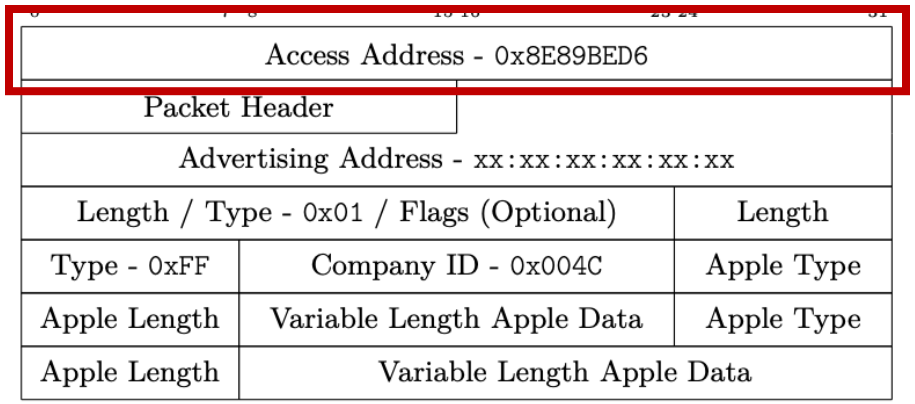

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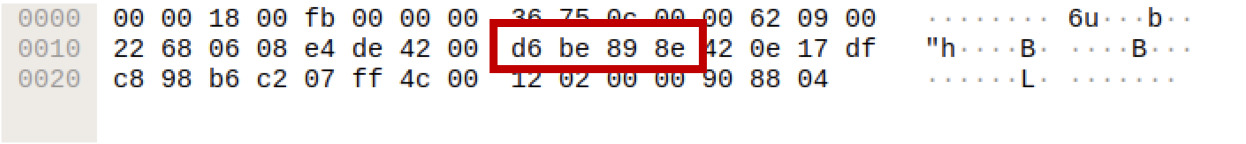

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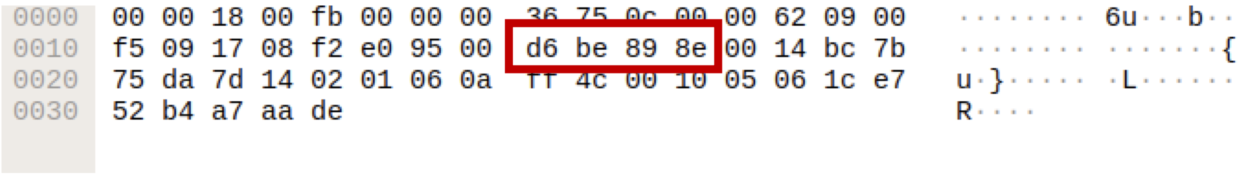

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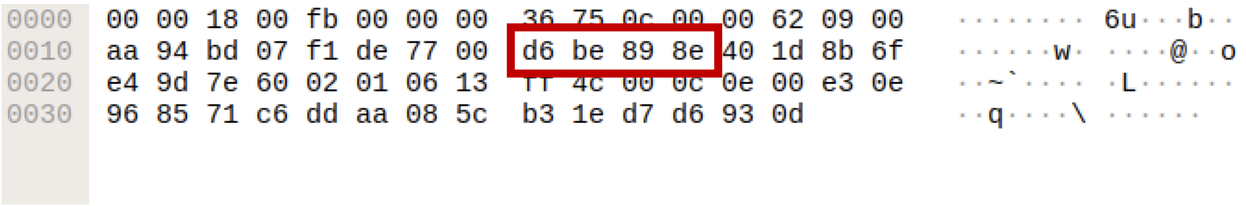

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The access address is at a 24 byte offset

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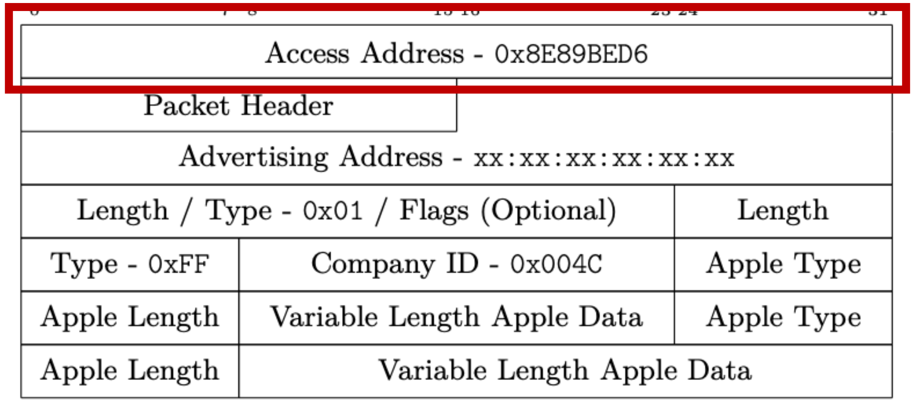

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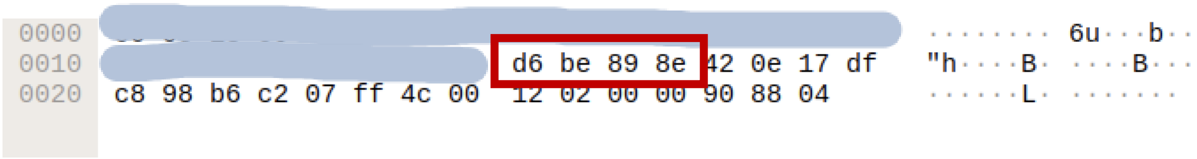

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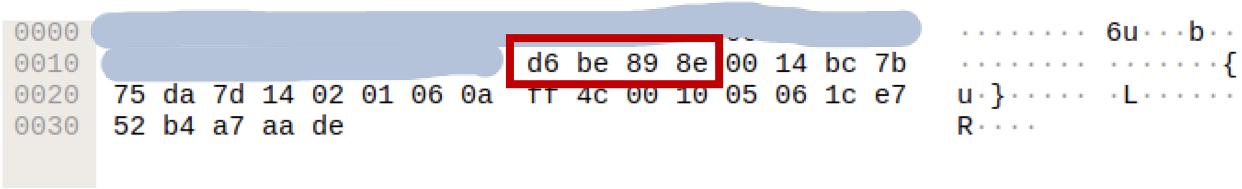

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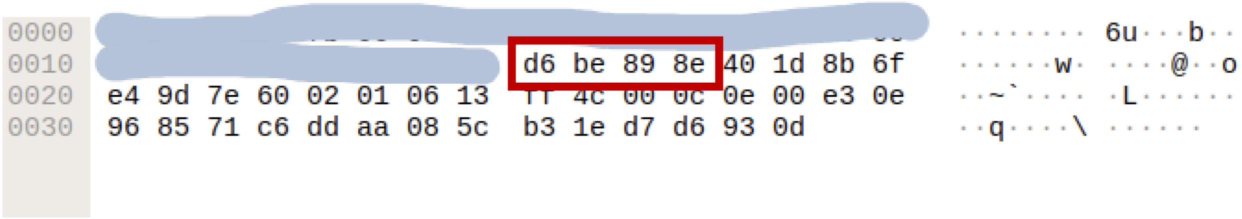

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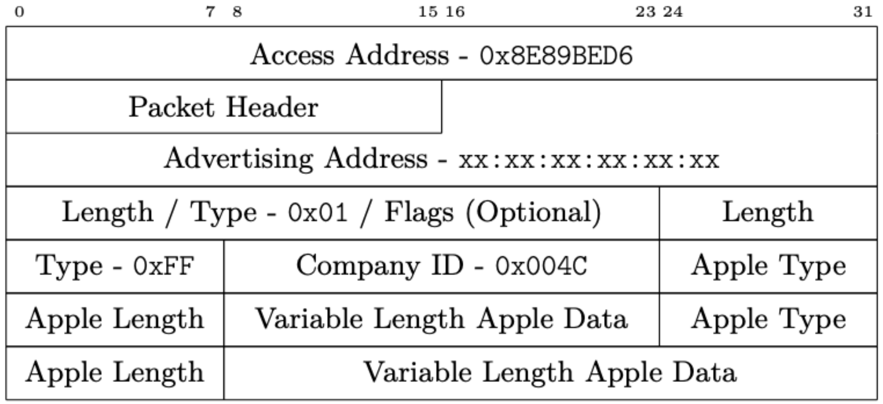

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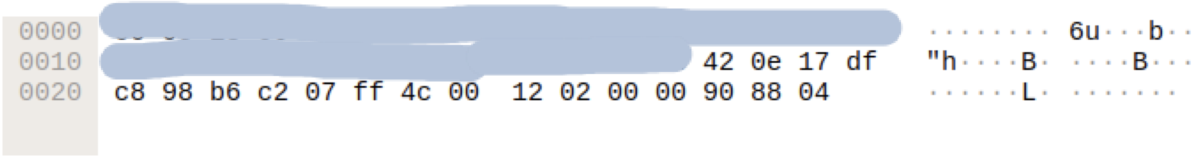

```
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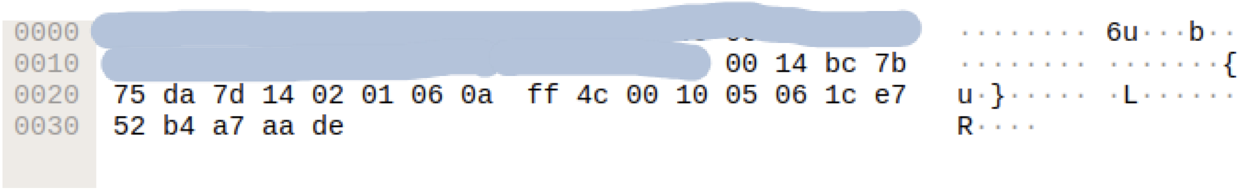

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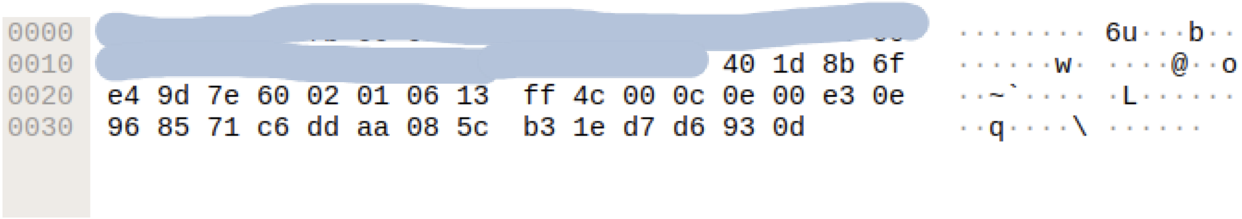

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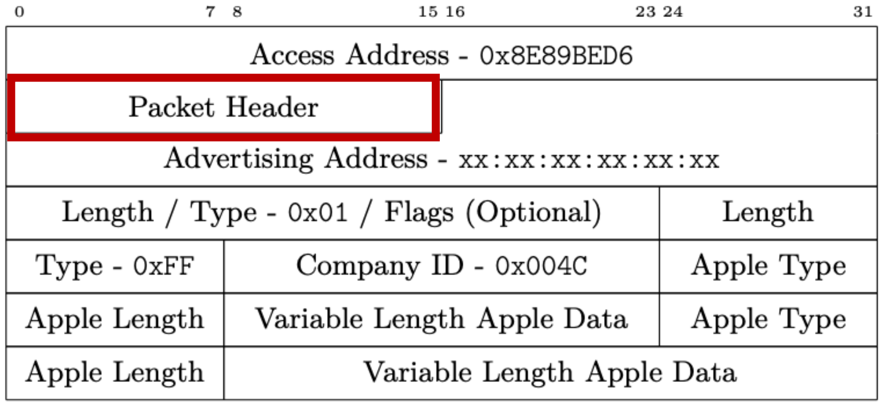

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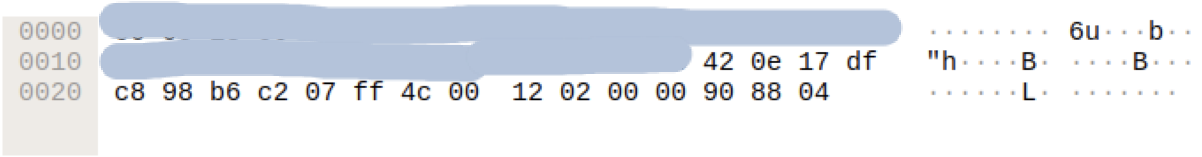

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0020 c8 98 b6 c2 07 ff 4c 00  12 02 00 00 90 88 04       ······L· ·······
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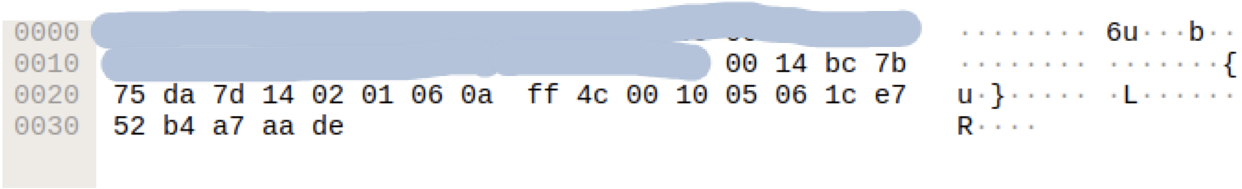

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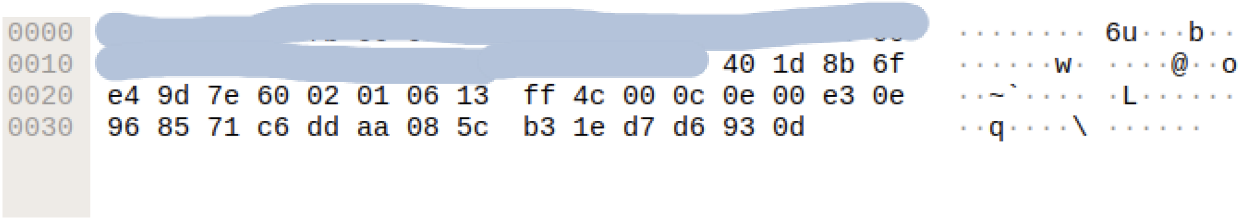

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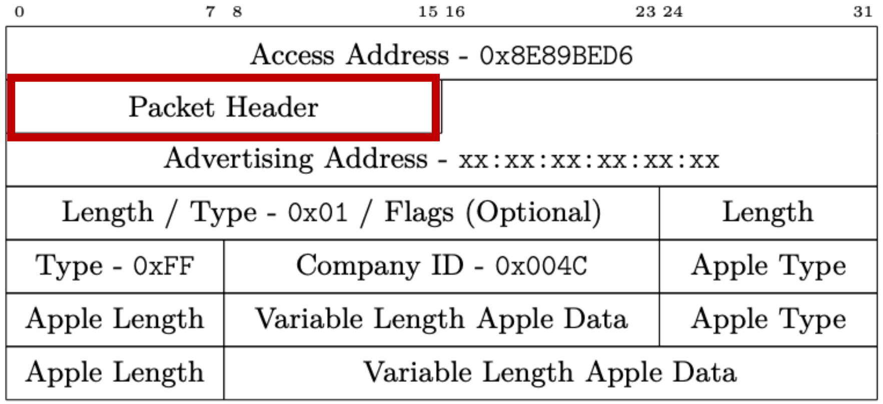

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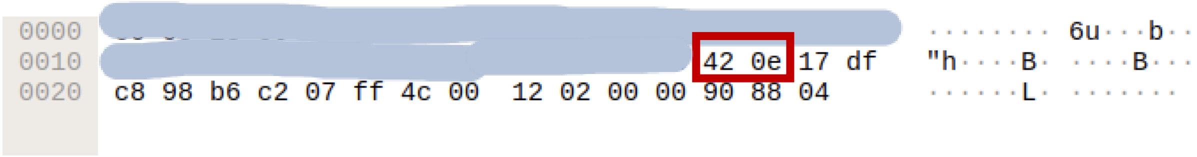

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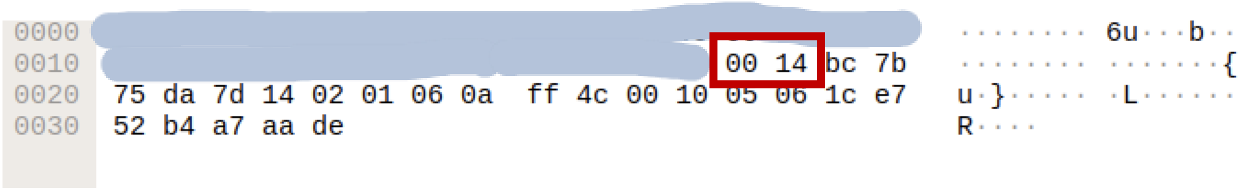

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0030  52 b4 a7 aa de                                      R····
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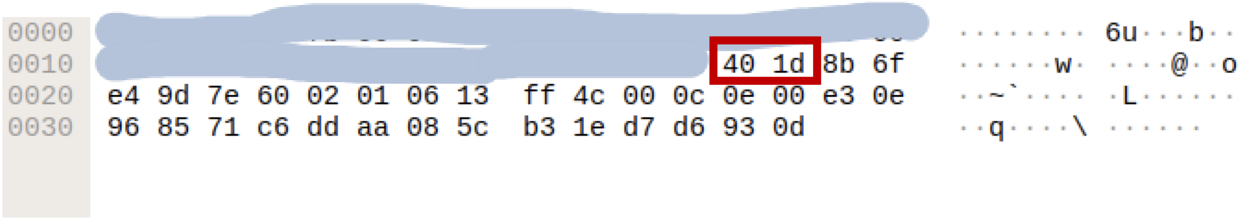

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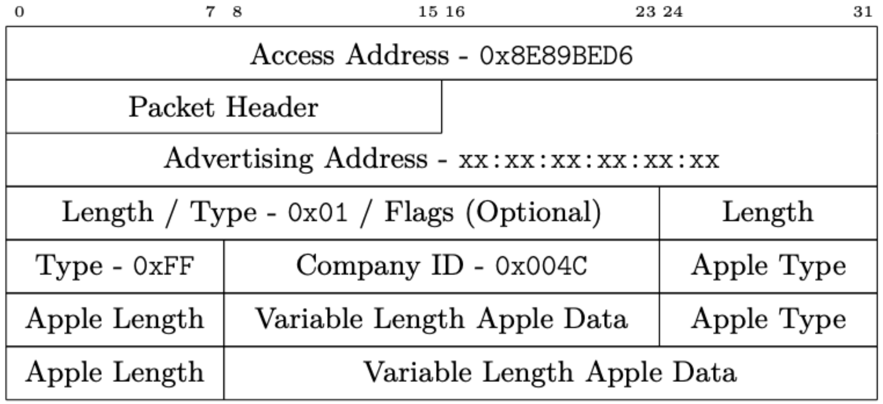

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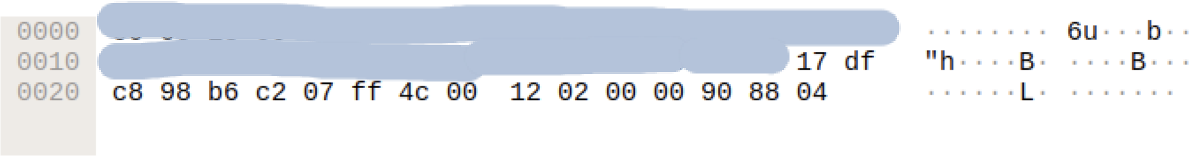

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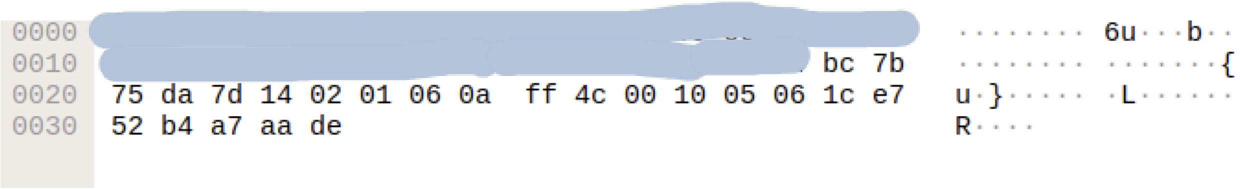

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0000  [redacted]                                           ········ 6u··b··
0010  [redacted]                                     bc 7b ········ ·······{
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0030  52 b4 a7 aa de                                       R····
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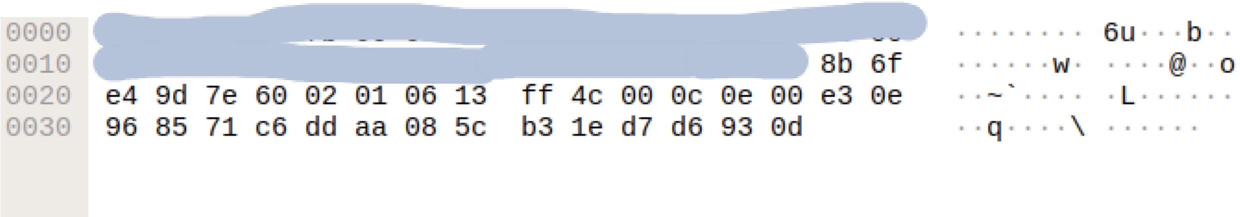

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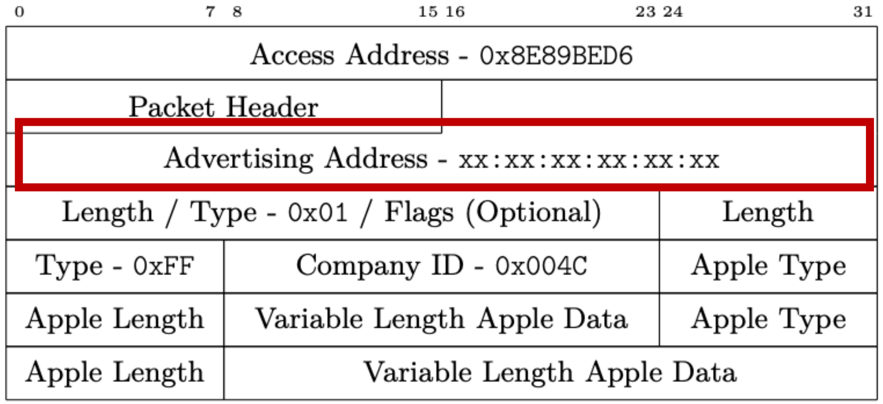

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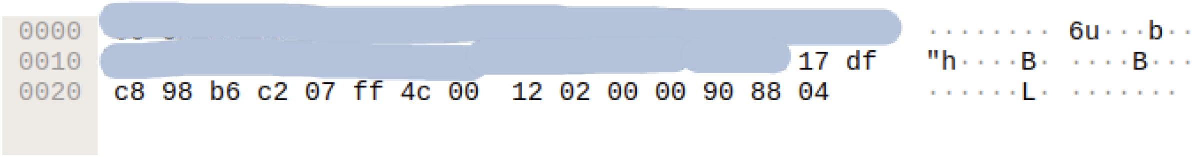
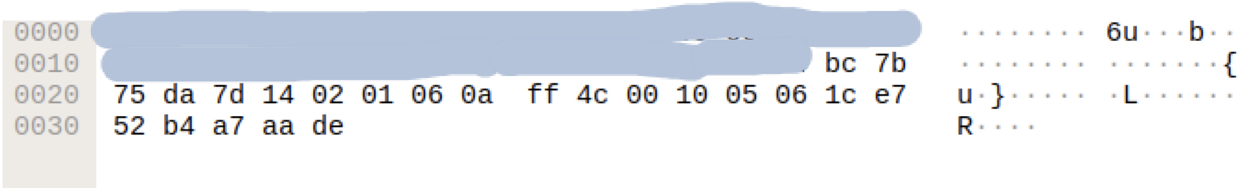
Apple Length	Variable Length Apple Data		

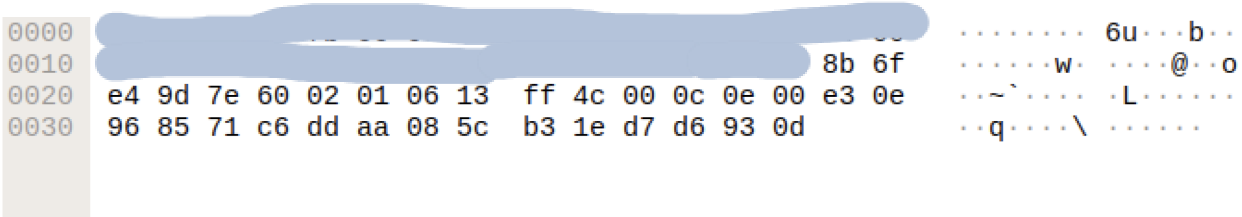
Apple BLE Frame Format



```
0000  [redacted]                                        ········ 6u··b··
0010  [redacted]                                  17 df "h····B· ····B···
0020  c8 98 b6 c2 07 ff 4c 00  12 02 00 00 90 88 04      ······L· ·······
```



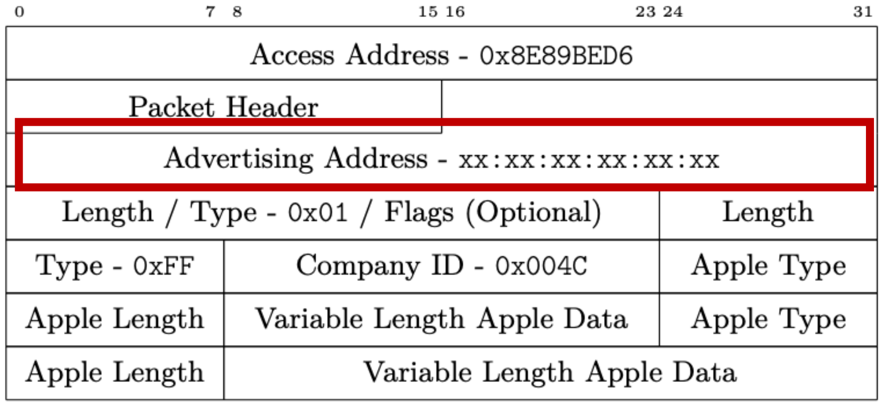
```
0000  [redacted]                                        ········ 6u··b··
0010  [redacted]                                  bc 7b ········ ·······{
0020  75 da 7d 14 02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                    R····
```



```
0000  [redacted]                                        ········ 6u··b··
0010  [redacted]                                  8b 6f ······w· ····@··o
0020  e4 9d 7e 60 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d        ··q···\ ······
```

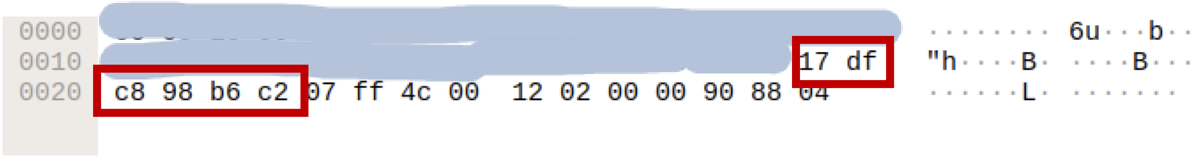
Continuity Protocol Explained

It’s not a bug, it’s a feature!

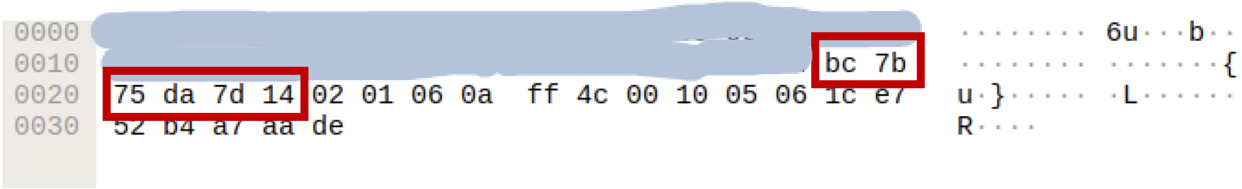


Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

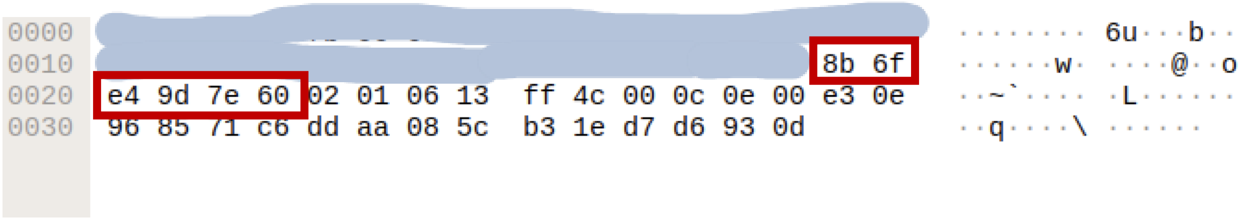
Apple BLE Frame Format



```
0000  [redacted]                                          ········ 6u···b··
0010  [redacted]                                    17 df  "h····B· ····B···
0020  c8 98 b6 c2 07 ff 4c 00  12 02 00 00 90 88 04        ······L· ·······
```



```
0000  [redacted]                                          ········ 6u···b··
0010  [redacted]                                    bc 7b  ········ ·······{
0020  75 da 7d 14 02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                     R····
```



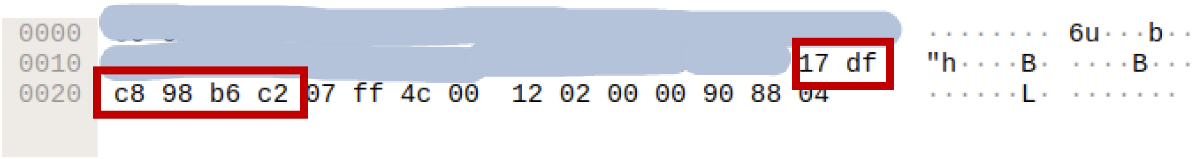
```
0000  [redacted]                                          ········ 6u···b··
0010  [redacted]                                    8b 6f  ······w· ····@··o
0020  e4 9d 7e 60 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d        ··q····\ ······
```

Continuity Protocol Explained

It's not a bug, it's a feature!

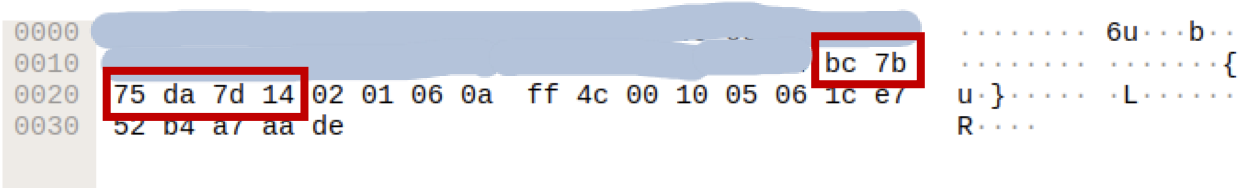
0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



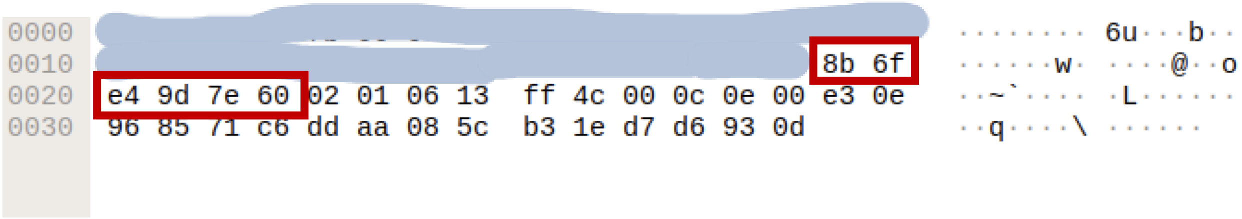
```
0000  [redacted]                                          ········ 6u···b··
0010                                               17 df  "h····B· ····B···
0020  c8 98 b6 c2 07 ff 4c 00  12 02 00 00 90 88 04       ······L· ········
```

c2:b6:98:c8:df:17



```
0000  [redacted]                                          ········ 6u···b··
0010                                               bc 7b  ········ ·······{
0020  75 da 7d 14 02 01 06 0a  ff 4c 00 10 05 06 1c e7    u·}····· ·L······
0030  52 b4 a7 aa de                                      R····
```

14:7d:da:75:7b:bc



```
0000  [redacted]                                          ········ 6u···b··
0010                                               8b 6f  ······w· ····@··o
0020  e4 9d 7e 60 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e    ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d          ··q····\ ······
```

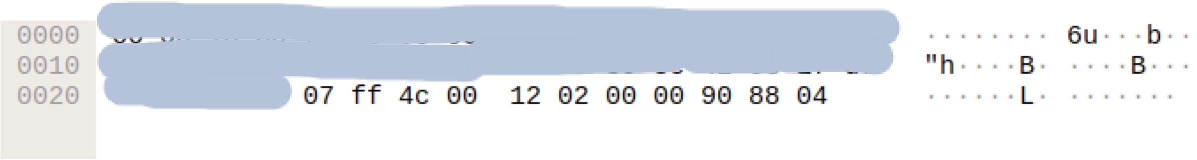
60:7e:9d:e4:6f:8b

Continuity Protocol Explained

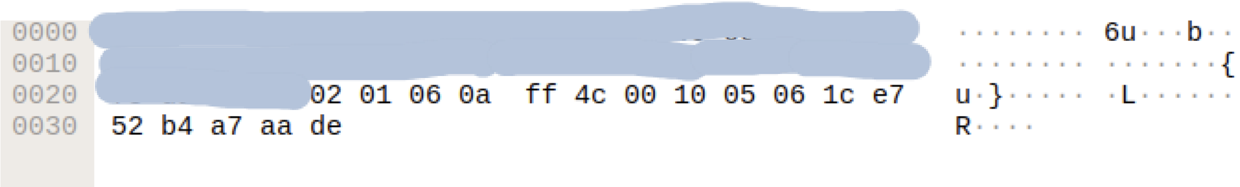
It's not a bug, it's a feature!

<table>
<tr><td>0 … 7</td><td>8 … 15</td><td>16 … 23</td><td>24 … 31</td></tr>
<tr><td colspan="4">Access Address - 0x8E89BED6</td></tr>
<tr><td colspan="2">Packet Header</td><td colspan="2"></td></tr>
<tr><td colspan="4">Advertising Address - xx:xx:xx:xx:xx:xx</td></tr>
<tr><td colspan="3">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td></tr>
</table>

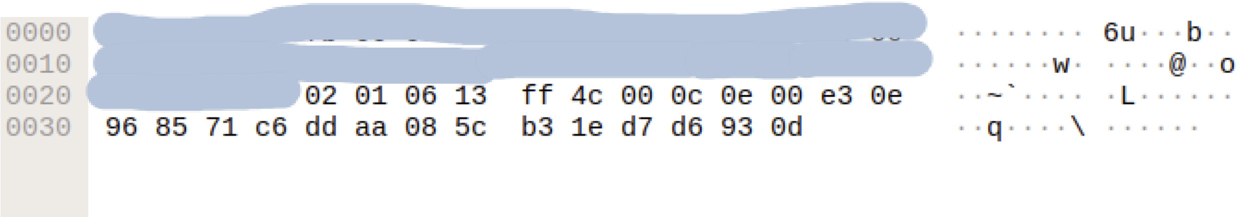
Apple BLE Frame Format



```
0000  [redacted]                                    ........ 6u...b..
0010  [redacted]                                    "h....B. ....B...
0020  [redacted]  07 ff 4c 00  12 02 00 00 90 88 04  ......L. .......
```



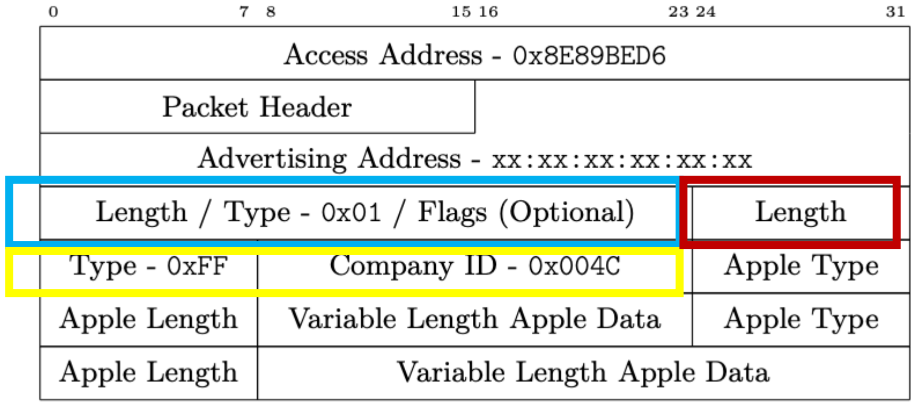
```
0000  [redacted]                                        ........ 6u...b..
0010  [redacted]                                        ........ .......{
0020  [redacted]  02 01 06 0a  ff 4c 00 10 05 06 1c e7  u.}..... .L......
0030  52 b4 a7 aa de                                    R....
```



```
0000  [redacted]                                        ........ 6u...b..
0010  [redacted]                                        ......w. ....@..o
0020  [redacted]  02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ..~`.... .L......
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d        ..q....\ ......
```

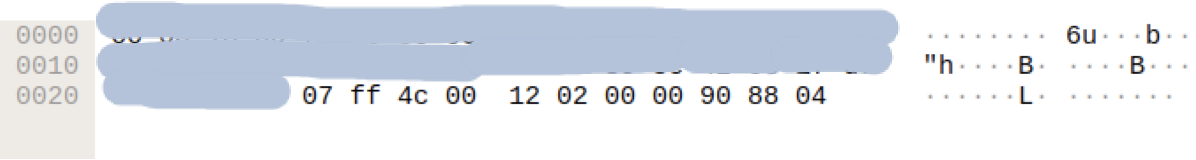
Continuity Protocol Explained

It's not a bug, it's a feature!

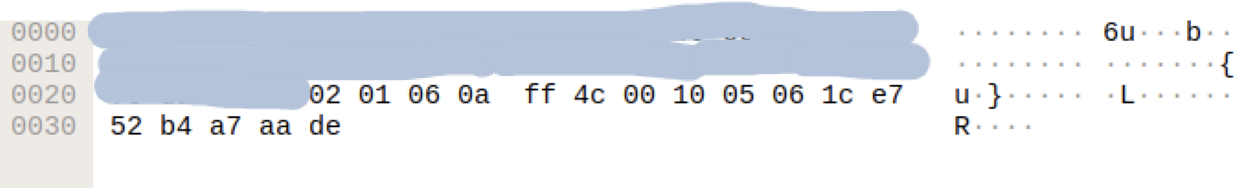


0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

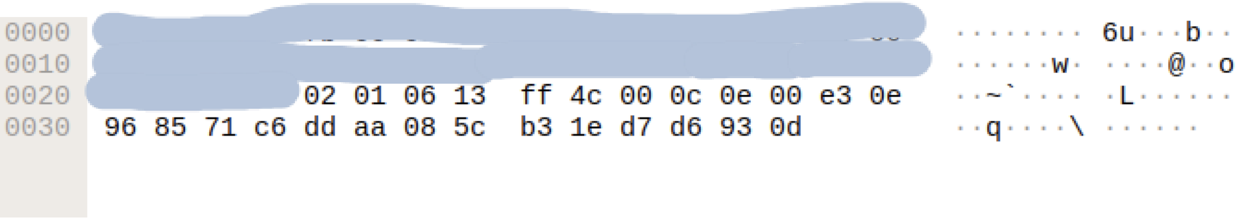
Apple BLE Frame Format



```
0000  [redacted]                                        ········ 6u···b··
0010                                                    "h···B·  ····B···
0020                 07 ff 4c 00  12 02 00 00 90 88 04  ······L· ·······
```



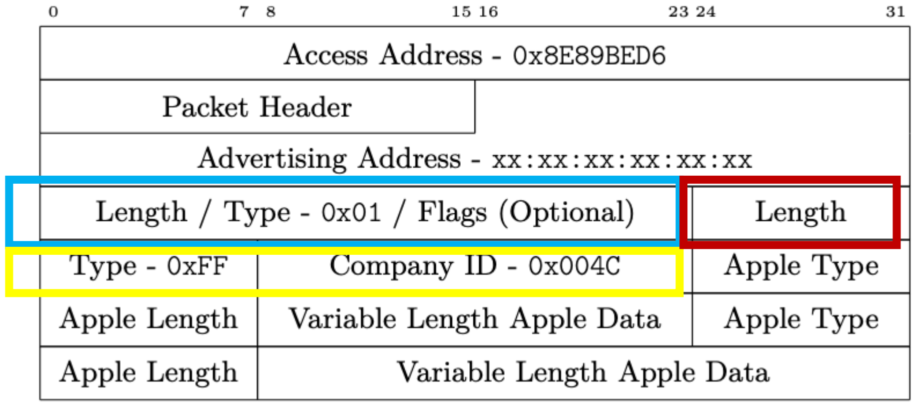
```
0000  [redacted]                                        ········ 6u···b··
0010                                                    ········ ·······{
0020                 02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                    R····
```



```
0000  [redacted]                                        ········ 6u···b··
0010                                                    ······w· ····@··o
0020                 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d         ··q····\ ······
```

Continuity Protocol Explained

It's not a bug, it's a feature!



Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

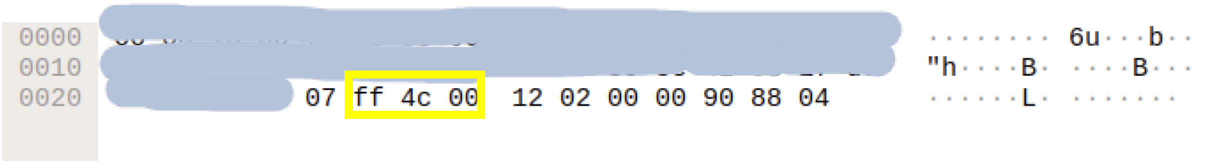
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

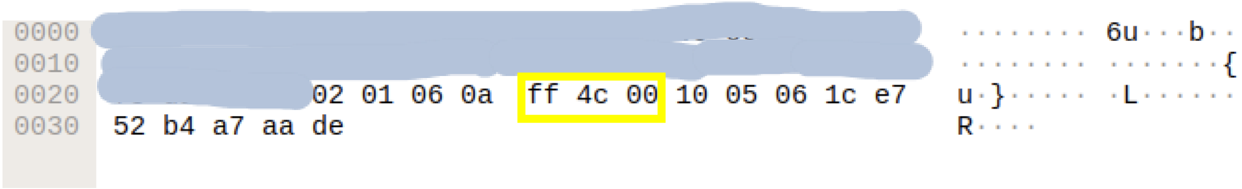
Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

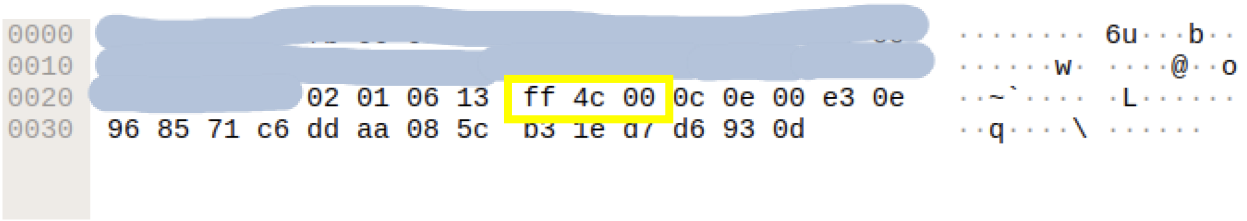
Apple BLE Frame Format



```
0000  [redacted]                                        ········ 6u···b··
0010                                                    "h····B· ····B···
0020               07 ff 4c 00  12 02 00 00 90 88 04    ······L· ·······
```



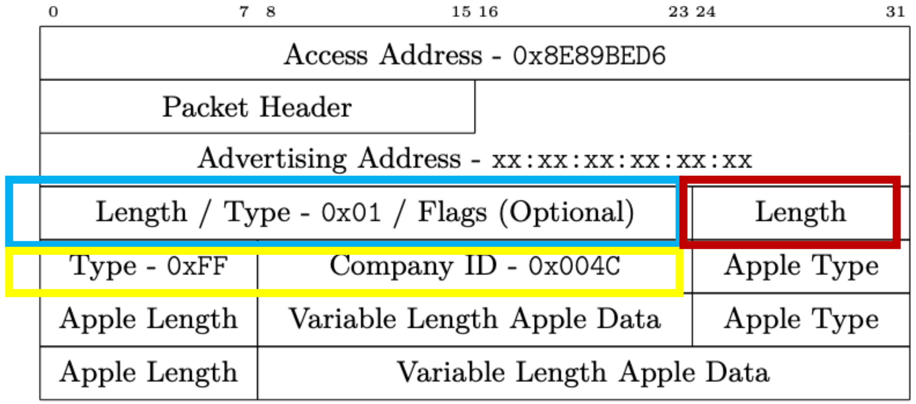
```
0000  [redacted]                                        ········ 6u···b··
0010                                                    ········ ·······{
0020               02 01 06 0a  ff 4c 00 10 05 06 1c e7 u·}····· ·L······
0030  52 b4 a7 aa de                                    R····
```



```
0000  [redacted]                                        ········ 6u···b··
0010                                                    ······w· ····@··o
0020               02 01 06 13  ff 4c 00 0c 0e 00 e3 0e ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d        ··q····\ ······
```

Continuity Protocol Explained

It's not a bug, it's a feature!



Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

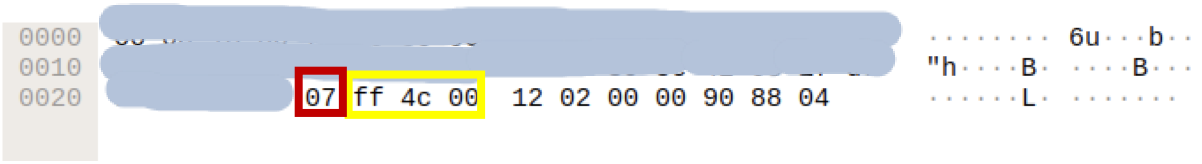
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

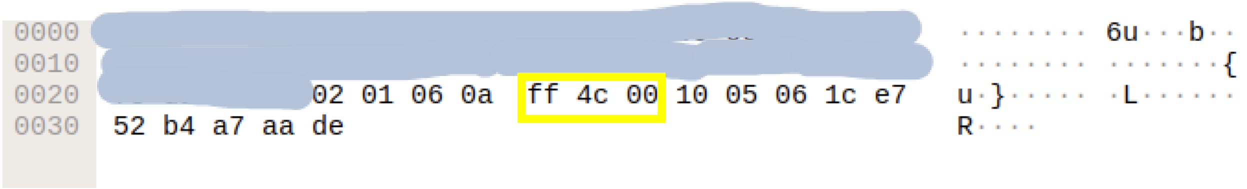
Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

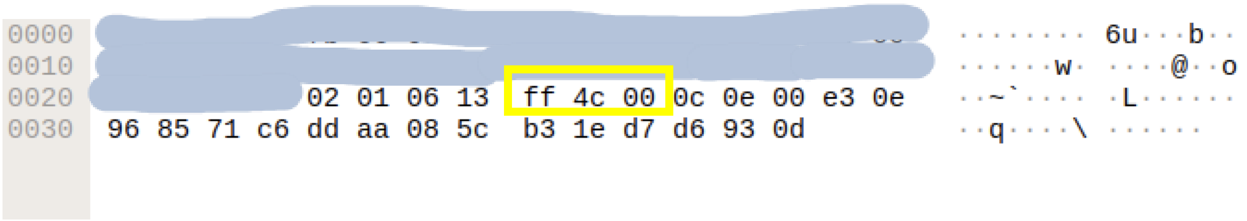
Apple BLE Frame Format



```
0000  [redacted]                                          ········ 6u···b··
0010                                                      "h····B· ····B···
0020                  07 ff 4c 00  12 02 00 00 90 88 04   ······L· ·······
```



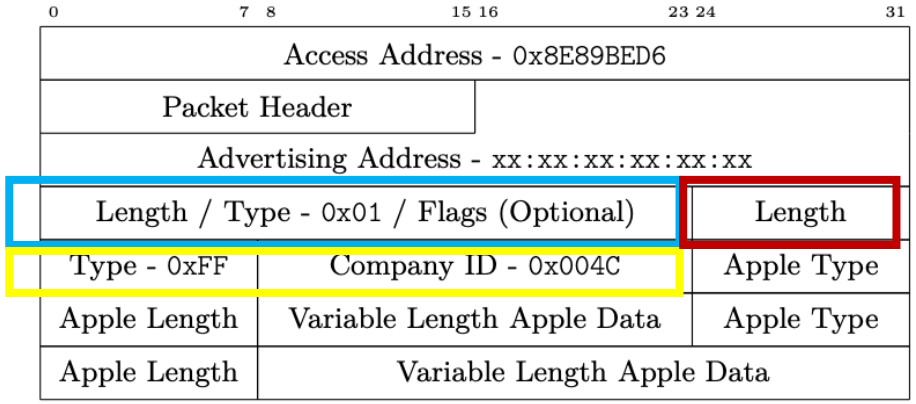
```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ········ ·······{
0020                 02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                      R····
```



```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ······w· ····@··o
0020                 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d          ··q····\ ······
```

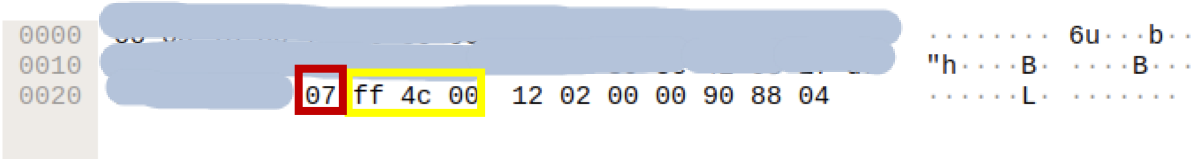
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

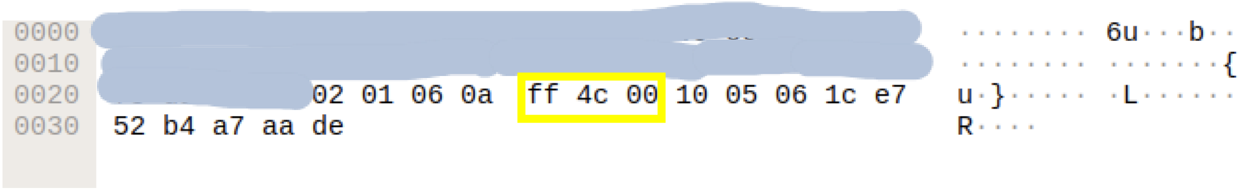
Apple BLE Frame Format



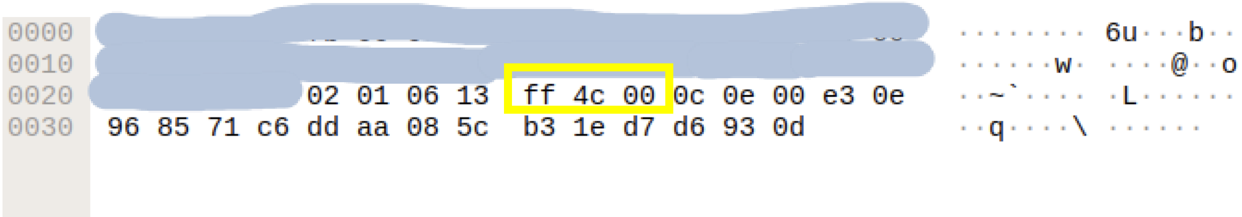
```
0000 [redacted]                                  ········ 6u··b··
0010 [redacted]                                  "h···B·  ····B···
0020 [redacted] 07 ff 4c 00  12 02 00 00 90 88 04  ······L· ·······
```

Length only

7 Bytes



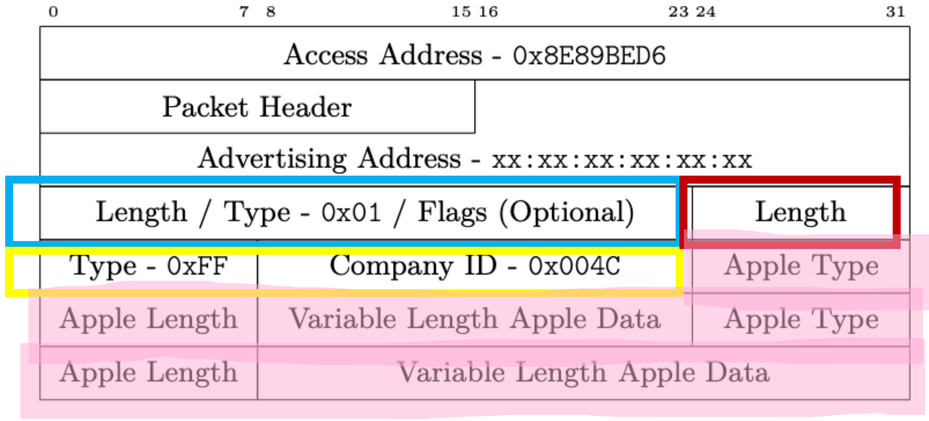
```
0000 [redacted]                                        ········ 6u··b··
0010 [redacted]                                        ········ ·······{
0020 [redacted] 02 01 06 0a  ff 4c 00 10 05 06 1c e7   u·}····· ·L······
0030 52 b4 a7 aa de                                    R····
```



```
0000 [redacted]                                        ········ 6u··b··
0010 [redacted]                                        ······w· ····@··o
0020 [redacted] 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e   ··~`···· ·L······
0030 96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d         ··q····\ ······
```

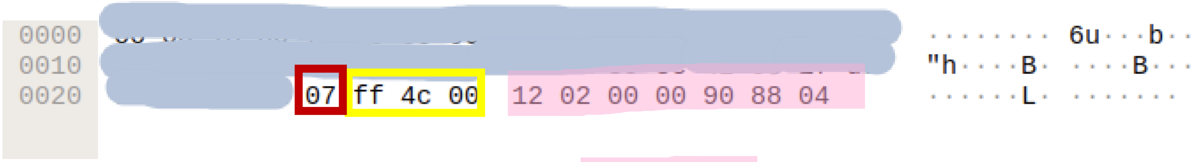
Continuity Protocol Explained

It's not a bug, it's a feature!



0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

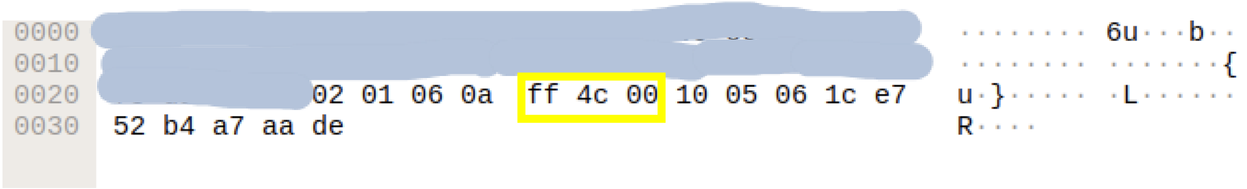
Apple BLE Frame Format



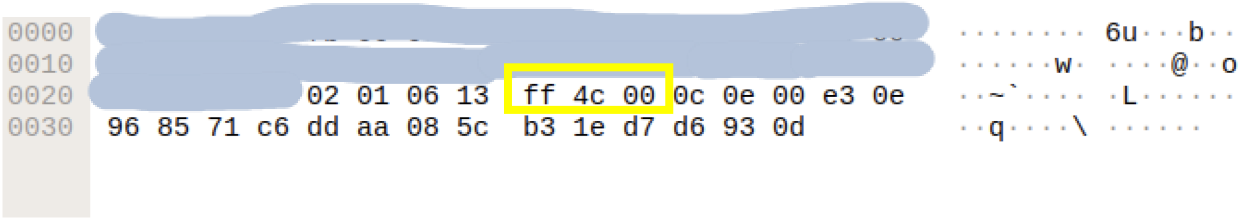
```
0000 [redacted]                                    ········ 6u··b··
0010                                               "h···B· ····B···
0020          07 ff 4c 00  12 02 00 00 90 88 04    ······L· ·······
```

Length only

7 Bytes



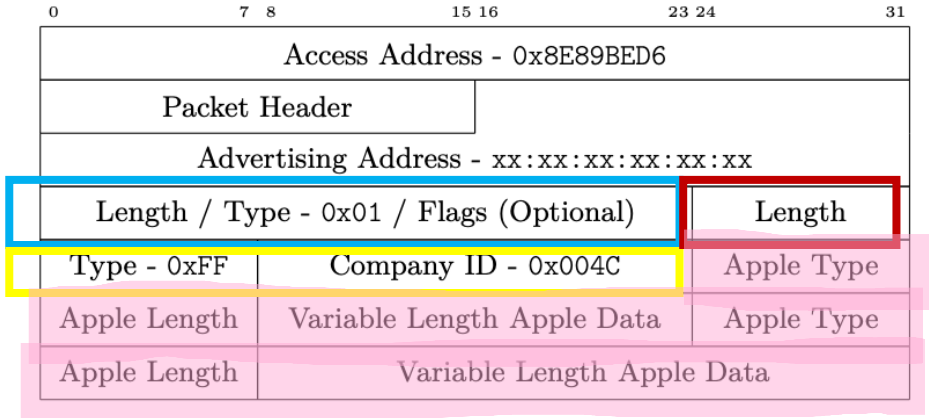
```
0000 [redacted]                                    ········ 6u··b··
0010                                               ········ ·······{
0020          02 01 06 0a  ff 4c 00 10 05 06 1c e7 u·}····· ·L······
0030 52 b4 a7 aa de                                R····
```



```
0000 [redacted]                                          ········ 6u··b··
0010                                                     ······w· ····@··o
0020          02 01 06 13  ff 4c 00 0c 0e 00 e3 0e       ··~`···· ·L······
0030 96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d          ··q····\ ······
```

Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 7 8 15 16 23 24 31

Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

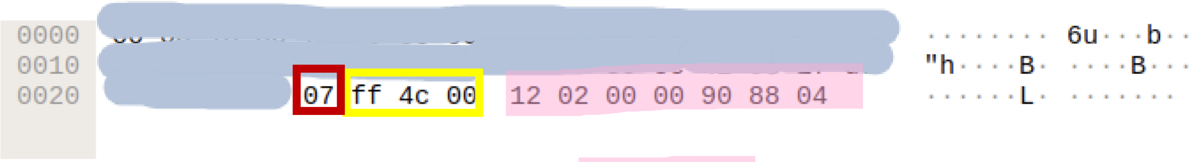
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

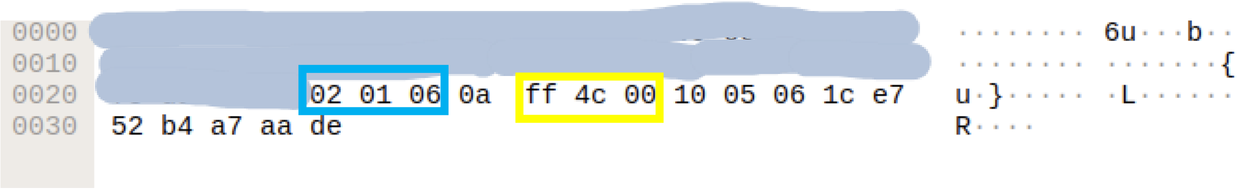
Apple BLE Frame Format



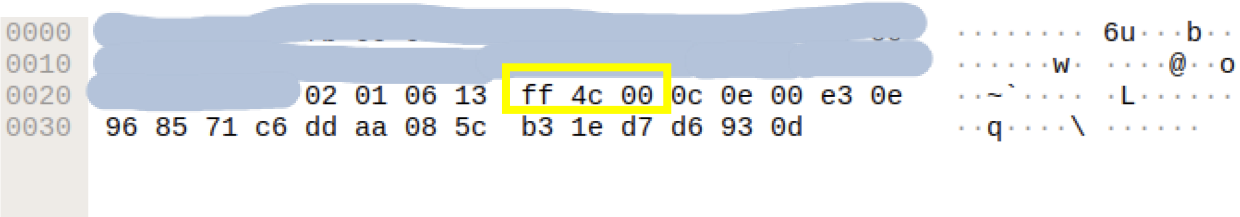
```
0000 [redacted]                                        ········ 6u···b··
0010                                                   "h····B· ····B···
0020            07 ff 4c 00  12 02 00 00 90 88 04      ······L· ·······
```

Length only

7 Bytes



```
0000 [redacted]                                        ········ 6u···b··
0010                                                   ········ ·······{
0020            02 01 06 0a  ff 4c 00 10 05 06 1c e7   u·}····· ·L······
0030 52 b4 a7 aa de                                    R····
```

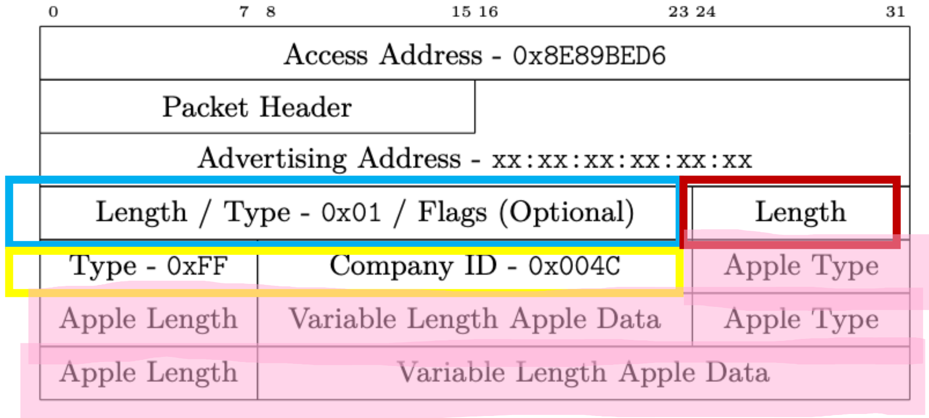


```
0000 [redacted]                                              ········ 6u···b··
0010                                                         ······w· ····@··o
0020             02 01 06 13  ff 4c 00 0c 0e 00 e3 0e        ··~`···· ·L······
0030 96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d              ··q····\ ······
```

BLE flags related to discoverability and transmission power (not Apple Specific)

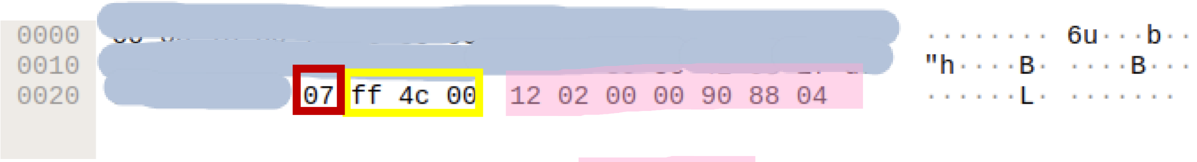
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

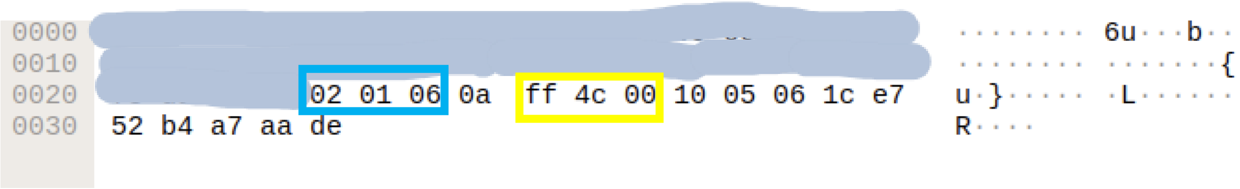
Apple BLE Frame Format



```
0000 [redacted]                                    ········ 6u···b··
0010                                               "h···B· ····B···
0020              07 ff 4c 00 12 02 00 00 90 88 04  ······L· ·······
```

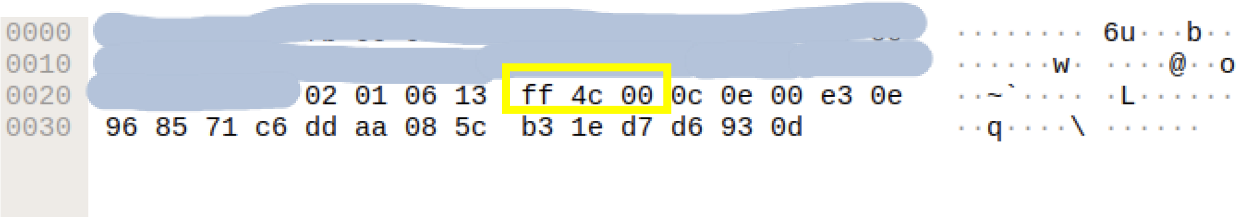
Length only

7 Bytes



```
0000 [redacted]                                     ········ 6u···b··
0010                                                ········ ·······{
0020              02 01 06 0a ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030 52 b4 a7 aa de                                 R····
```

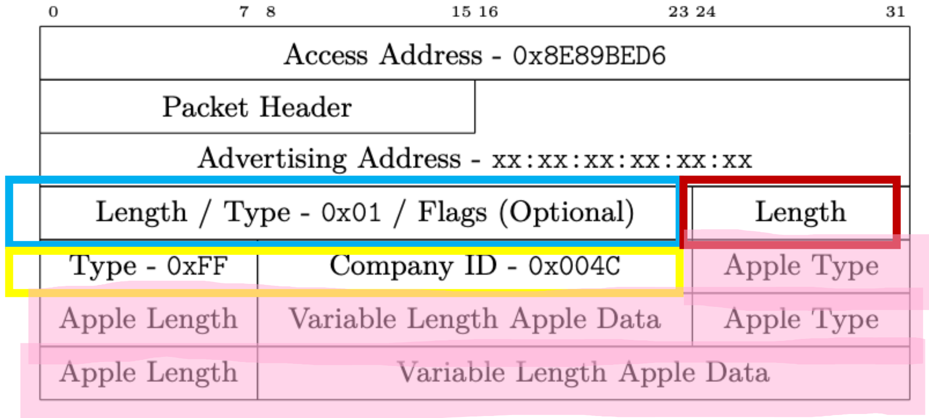
Length 0x2, 2 bytes of flag info



```
0000 [redacted]                                        ········ 6u···b··
0010                                                   ······w· ····@··o
0020              02 01 06 13 ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030 96 85 71 c6 dd aa 08 5c b3 1e d7 d6 93 0d         ··q···\ ······
```

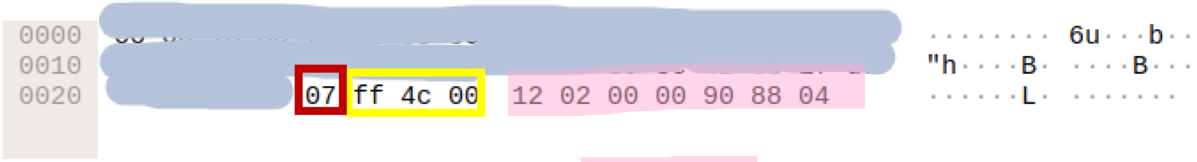
Continuity Protocol Explained

It’s not a bug, it’s a feature!



0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

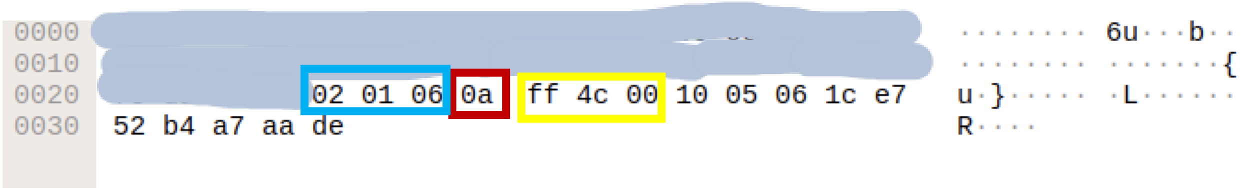
Apple BLE Frame Format



```
0000  [redacted]                                   ........ 6u··b··
0010  [redacted]                                   "h···B·  ···B···
0020  [redacted] 07 ff 4c 00  12 02 00 00 90 88 04  ······L· ·······
```

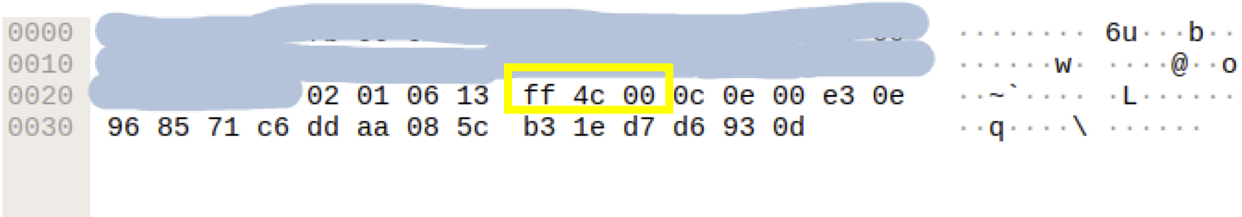
Length only

7 Bytes



```
0000  [redacted]                                    ········ 6u··b··
0010  [redacted]                                    ········ ······{
0020  [redacted] 02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                R····
```

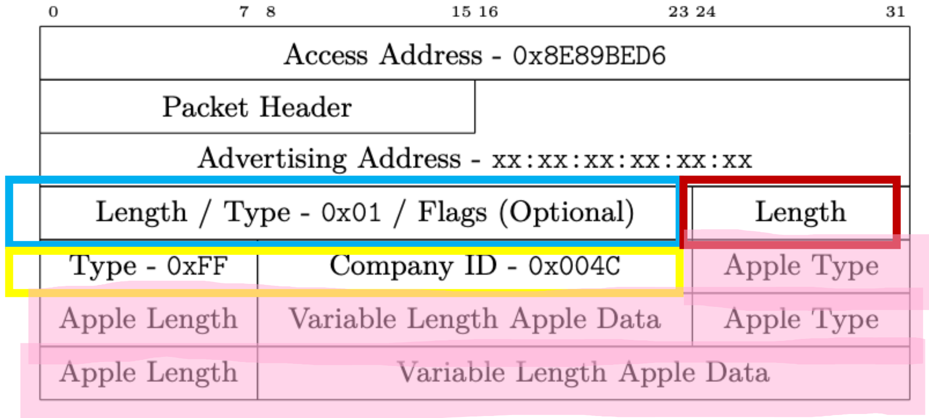
Length 0x2, 2 bytes of flag info



```
0000  [redacted]                                     ········ 6u··b··
0010  [redacted]                                     ······w· ····@··o
0020  [redacted] 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d       ··q····\ ······
```

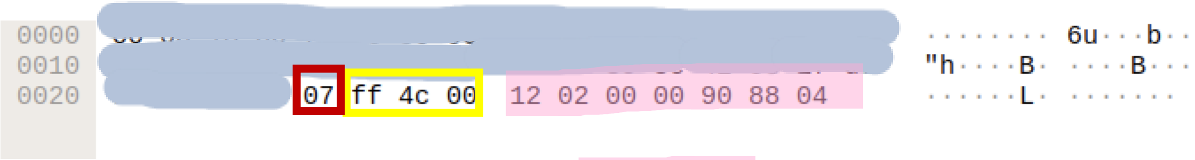
Continuity Protocol Explained

It's not a bug, it's a feature!



0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

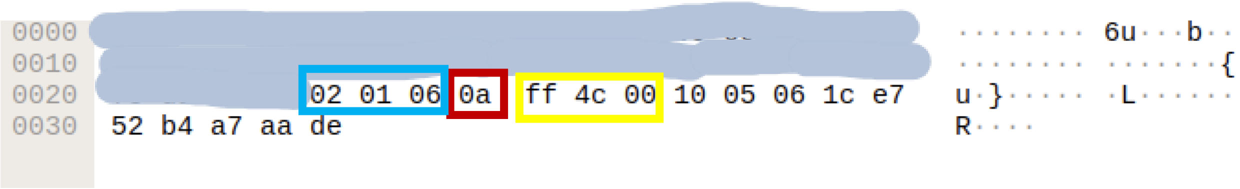
Apple BLE Frame Format



```
0000  [redacted]                                     ········ 6u··b··
0010  [redacted]                                     "h···B·  ···B···
0020  [redacted]  07 ff 4c 00  12 02 00 00 90 88 04  ······L· ·······
```

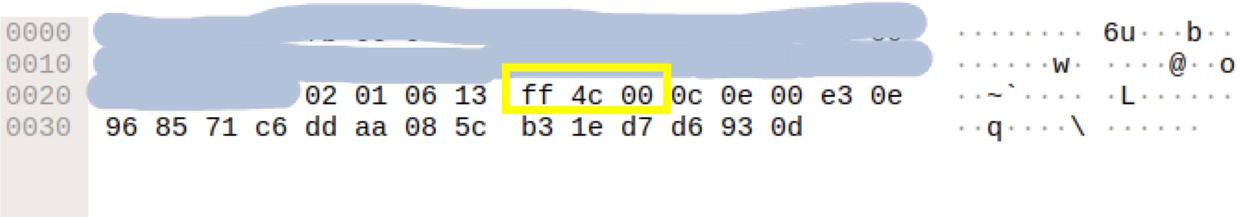
Length only

7 Bytes



```
0000  [redacted]                                        ········ 6u··b··
0010  [redacted]                                        ········ ·······{
0020  [redacted]  02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                    R····
```

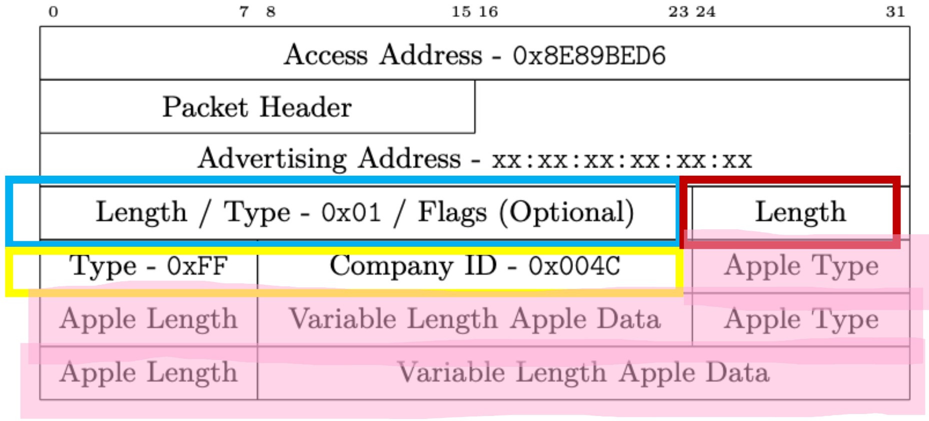
Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding



```
0000  [redacted]                                                  ········ 6u··b··
0010  [redacted]                                                  ······w· ····@··o
0020  [redacted]              02 01 06 13  ff 4c 00 0c 0e 00 e3 0e ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d                  ··q···\  ······
```

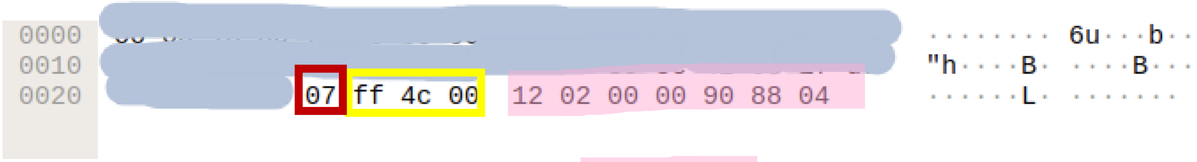
Continuity Protocol Explained

It's not a bug, it's a feature!



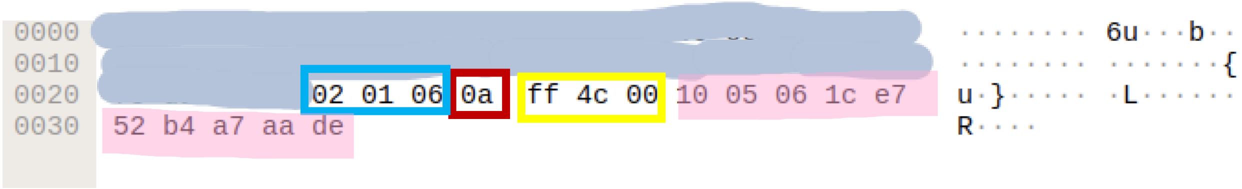
0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

Apple BLE Frame Format



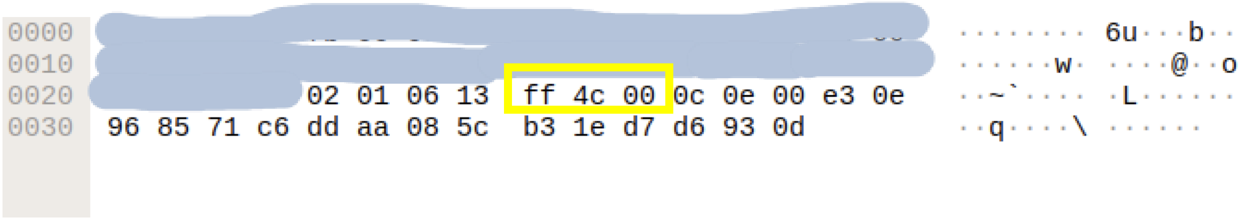
```
0000  [redacted]                                       ·········· 6u···b··
0010                                                   "h····B·  ····B···
0020                   07 ff 4c 00  12 02 00 00 90 88 04  ·······L·  ········
```

Length only 7 Bytes



```
0000  [redacted]                                          ·········· 6u···b··
0010                                                      ·········  ········{
0020                  02 01 06 0a  ff 4c 00 10 05 06 1c e7  u·}·····  ·L·······
0030  52 b4 a7 aa de                                       R····
```

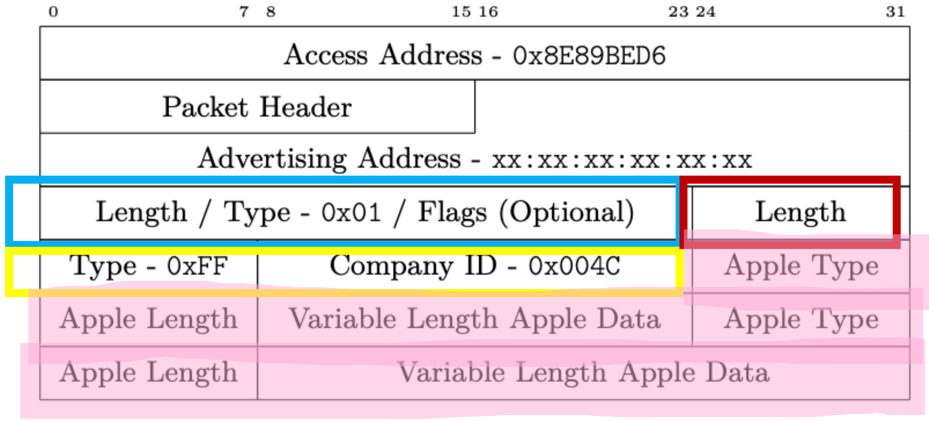
Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding



```
0000  [redacted]                                          ·········· 6u···b··
0010                                                      ·······w·  ····@··o
0020                  02 01 06 13  ff 4c 00 0c 0e 00 e3 0e  ··~`·····  ·L·······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d           ··q····\  ·······
```

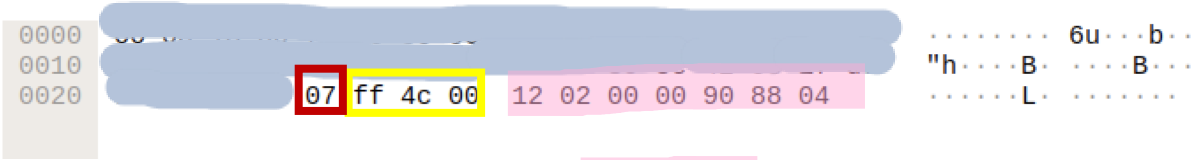
Continuity Protocol Explained

It’s not a bug, it’s a feature!



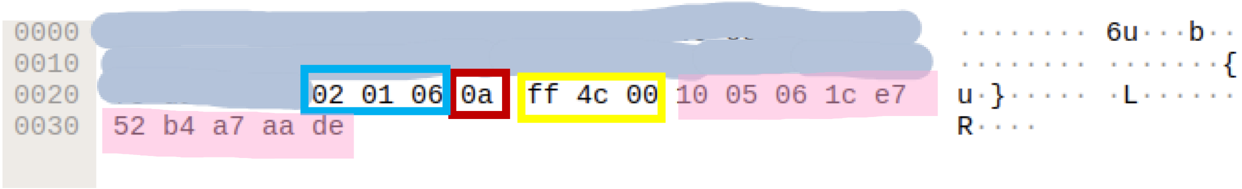
0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



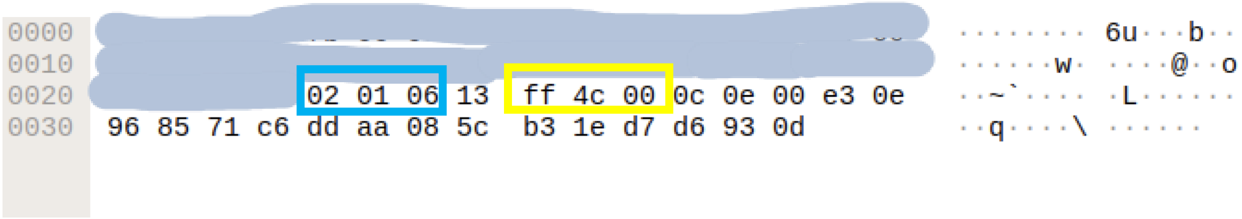
```
0000  [redacted]                                            ........ 6u..b..
0010  [redacted]                                            "h...B.  ....B...
0020  [redacted] 07 ff 4c 00  12 02 00 00 90 88 04          ......L. .......
```

Length only 7 Bytes



```
0000  [redacted]                                            ........ 6u..b..
0010  [redacted]                                            ........ .......{
0020  [redacted] 02 01 06 0a  ff 4c 00 10 05 06 1c e7       u.}..... .L......
0030  52 b4 a7 aa de                                        R....
```

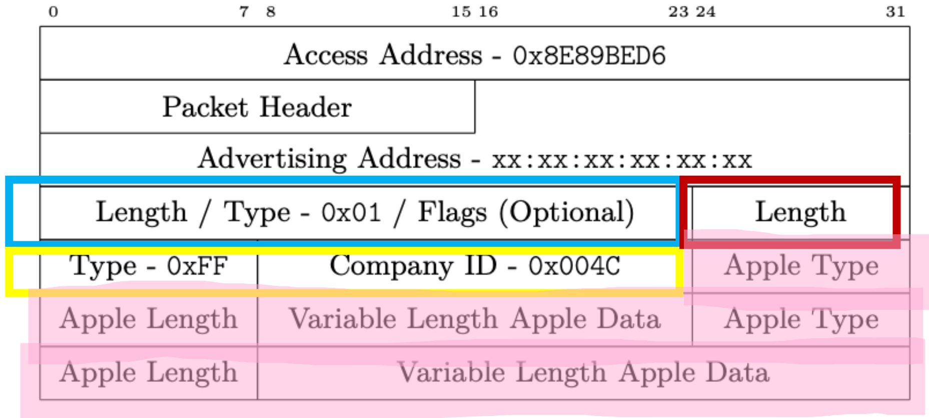
Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding



```
0000  [redacted]                                            ........ 6u..b..
0010  [redacted]                                            ......w. ....@..o
0020  [redacted] 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e       ..~`.... .L......
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d            ..q....\ ......
```

Continuity Protocol Explained

It's not a bug, it's a feature!



0 7 8 15 16 23 24 31

Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

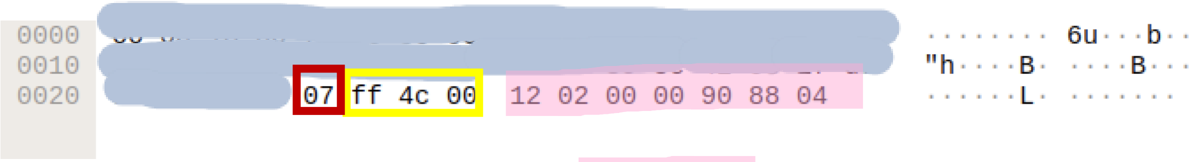
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

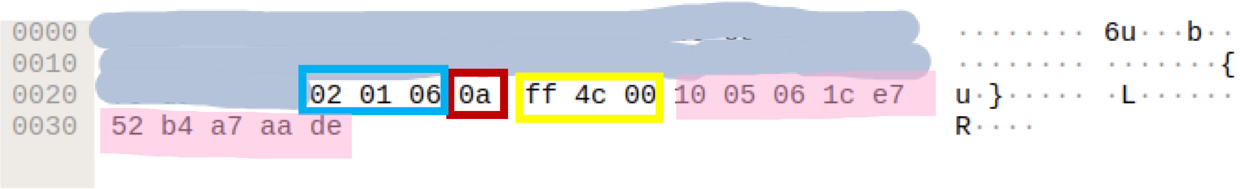
Apple BLE Frame Format



```
0000  [redacted]                                   ········ 6u··b··
0010                                                "h···B· ····B···
0020  07 ff 4c 00 12 02 00 00 90 88 04             ······L· ·······
```

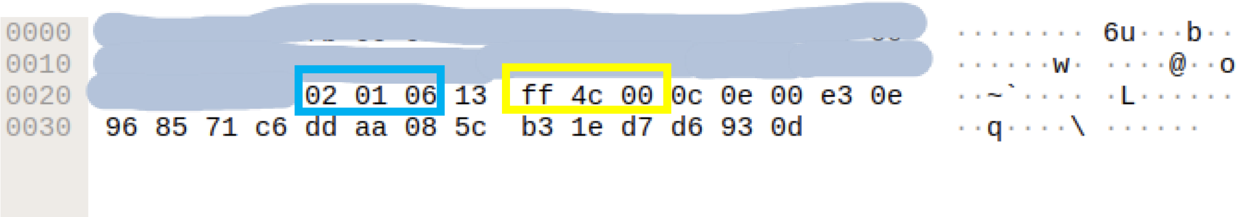
Length only

7 Bytes



```
0000  [redacted]                                   ········ 6u··b··
0010                                               ········ ·······{
0020  02 01 06 0a ff 4c 00 10 05 06 1c e7          u·}····· ·L······
0030  52 b4 a7 aa de                               R····
```

Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding

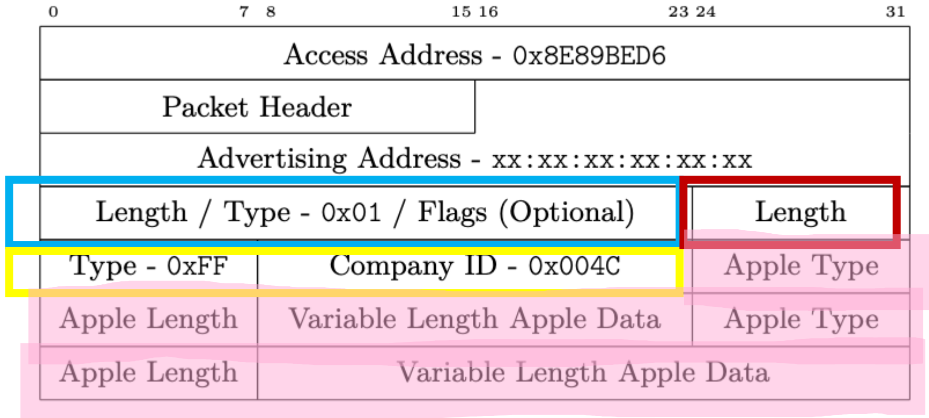


```
0000  [redacted]                                       ········ 6u··b··
0010                                                   ······w· ····@··o
0020  02 01 06 13 ff 4c 00 0c 0e 00 e3 0e              ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c b3 1e d7 d6 93 0d        ··q····\ ······
```

Length 0x2, 2 bytes of flag info

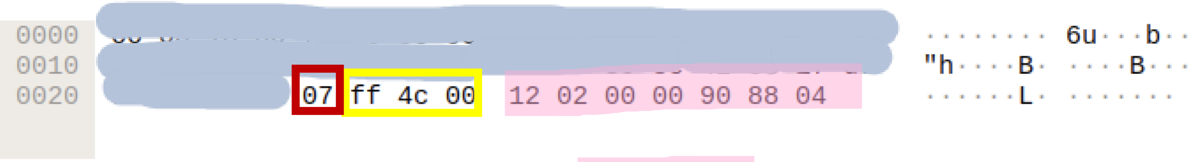
Continuity Protocol Explained

It’s not a bug, it’s a feature!



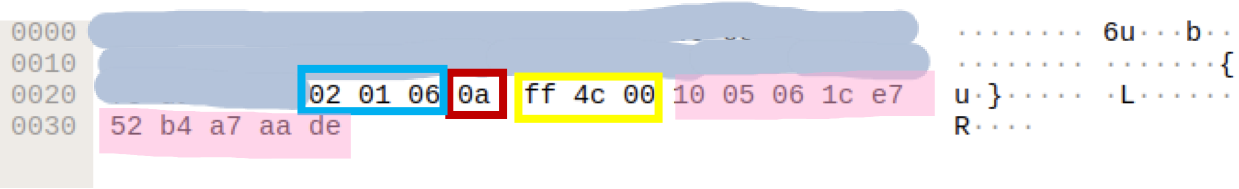
0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



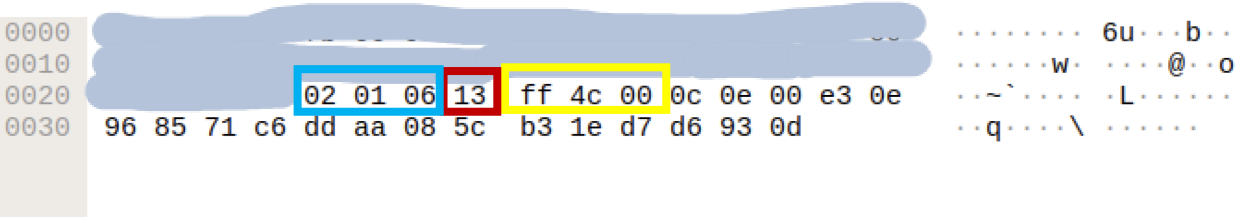
```
0000  [redacted]                                        ........ 6u··b··
0010  [redacted]                                        "h····B· ····B···
0020  [redacted]   07 ff 4c 00  12 02 00 00 90 88 04   ······L· ·······
```

Length only 7 Bytes



```
0000  [redacted]                                              ········ 6u··b··
0010  [redacted]                                              ········ ·······{
0020  [redacted]  02 01 06 0a  ff 4c 00 10 05 06 1c e7       u·}····· ·L······
0030  52 b4 a7 aa de                                         R····
```

Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding

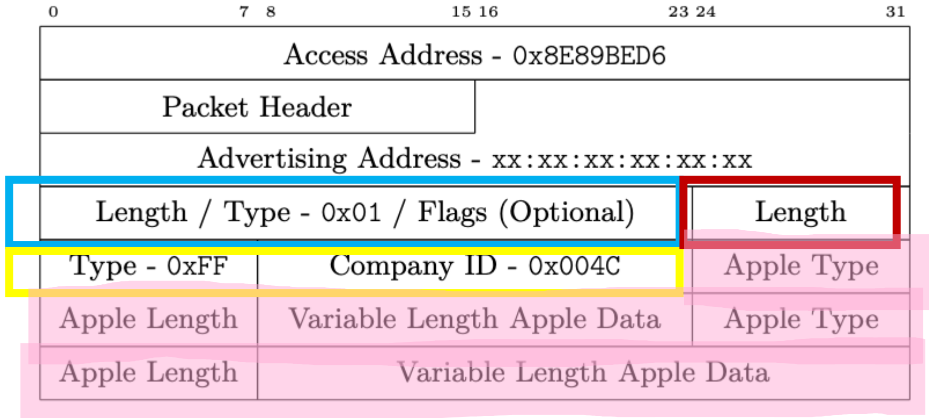


```
0000  [redacted]                                              ········ 6u··b··
0010  [redacted]                                              ······w· ····@··o
0020  [redacted]  02 01 06 13  ff 4c 00 0c 0e 00 e3 0e        ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d              ··q····\ ······
```

Length 0x2, 2 bytes of flag info

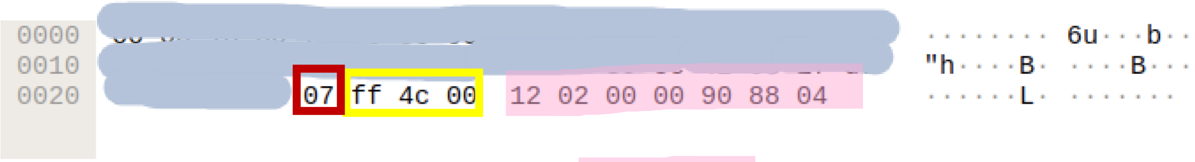
Continuity Protocol Explained

It’s not a bug, it’s a feature!



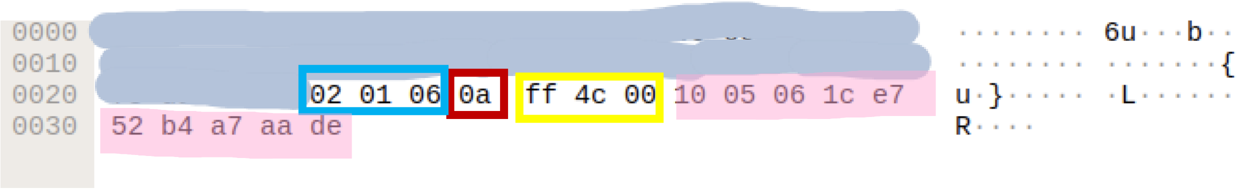
0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



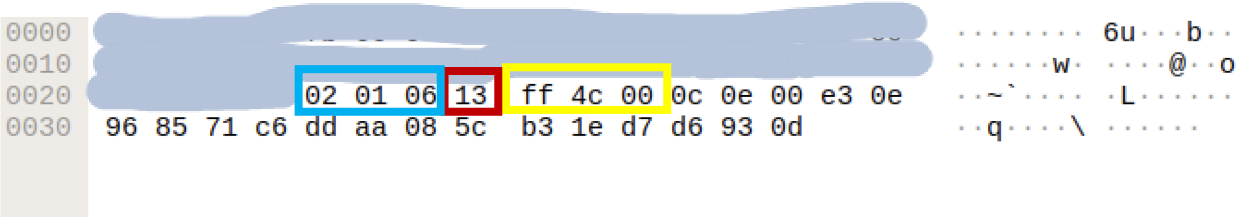
```
0000  [redacted]                                      ········ 6u··b··
0010  [redacted]                                      "h···B·  ···B···
0020  [redacted] 07 ff 4c 00 12 02 00 00 90 88 04    ······L· ·······
```

Length only   7 Bytes



```
0000  [redacted]                                         ········  6u··b··
0010  [redacted]                                         ········  ·······{
0020  [redacted] 02 01 06 0a  ff 4c 00 10 05 06 1c e7    u·}·····  ·L······
0030  52 b4 a7 aa de                                     R····
```

Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding

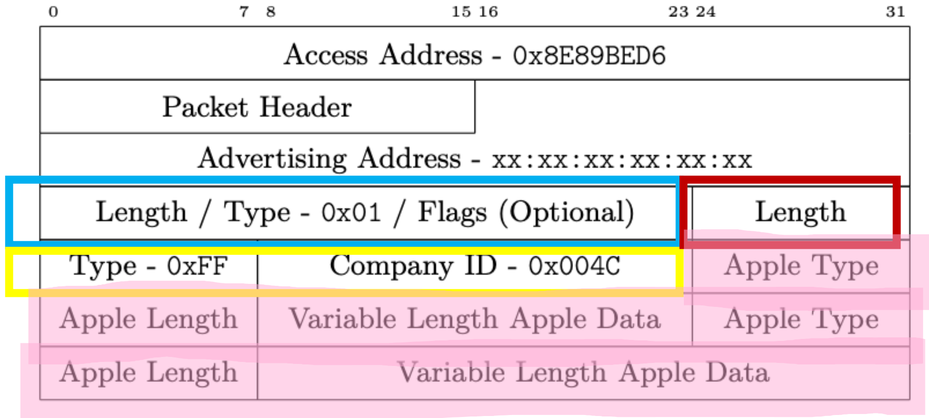


```
0000  [redacted]                                         ········  6u··b··
0010  [redacted]                                         ······w·  ····@··o
0020  [redacted] 02 01 06 13  ff 4c 00 0c 0e 00 e3 0e    ··~`····  ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d         ··q····\  ······
```

Length 0x2, 2 bytes of flag info Length 0x13, 19 bytes succeeding

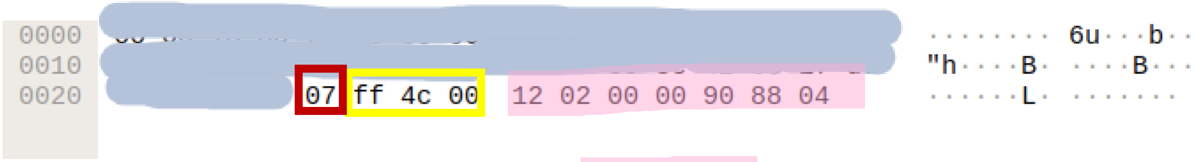
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

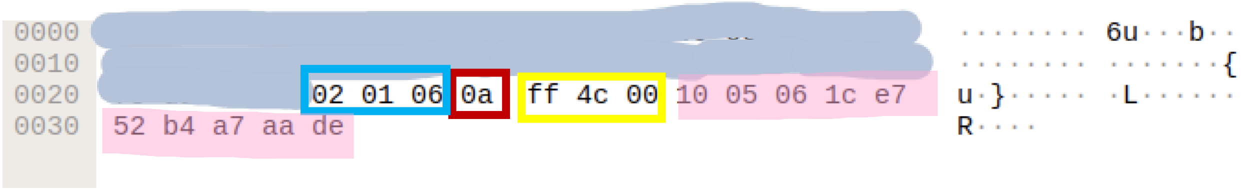
Apple BLE Frame Format



```
0000  [redacted]                                    ········ 6u··b··
0010  [redacted]                                    "h···B·  ···B···
0020  [redacted] 07 ff 4c 00 12 02 00 00 90 88 04   ······L· ·······
```

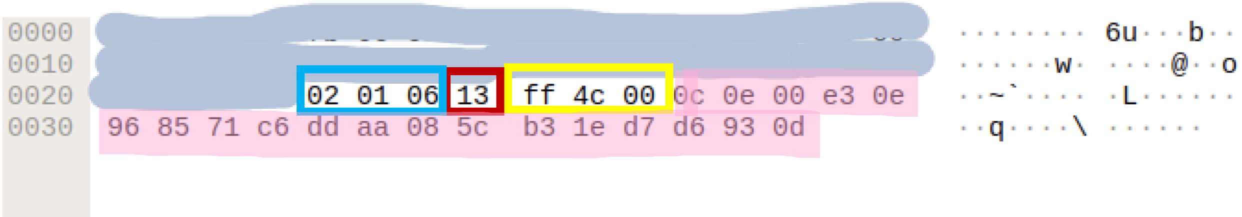
Length only

7 Bytes



```
0000  [redacted]                                          ········ 6u··b··
0010  [redacted]                                          ········ ·······{
0020  [redacted] 02 01 06 0a ff 4c 00 10 05 06 1c e7      u·}····· ·L······
0030  52 b4 a7 aa de                                      R····
```

Length 0x2, 2 bytes of flag info Length 0xa, 10 bytes succeeding



```
0000  [redacted]                                          ········ 6u··b··
0010  [redacted]                                          ······w· ····@··o
0020  [redacted] 02 01 06 13 ff 4c 00 0c 0e 00 e3 0e      ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c b3 1e d7 d6 93 0d           ··q····\ ······
```

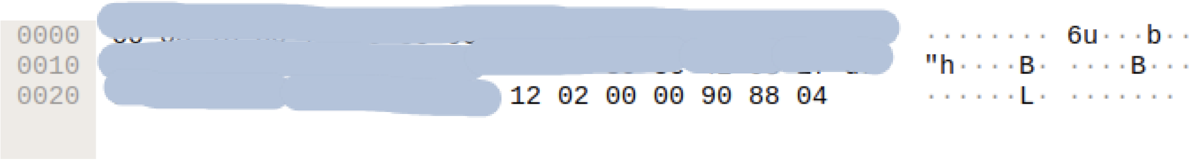
Length 0x2, 2 bytes of flag info Length 0x13, 19 bytes succeeding

Continuity Protocol Explained

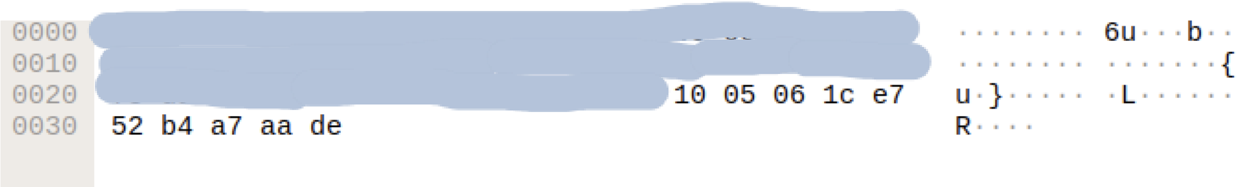
It's not a bug, it's a feature!

<table>
<tr><td>0</td><td>7 8</td><td>15 16</td><td>23 24</td><td>31</td></tr>
<tr><td colspan="5">Access Address - 0x8E89BED6</td></tr>
<tr><td colspan="2">Packet Header</td><td colspan="3"></td></tr>
<tr><td colspan="5">Advertising Address - xx:xx:xx:xx:xx:xx</td></tr>
<tr><td colspan="4">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="3">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="4">Variable Length Apple Data</td></tr>
</table>

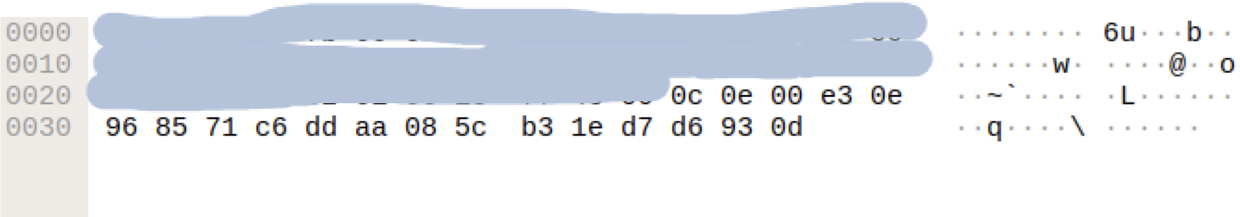
Apple BLE Frame Format



```
0000  [redacted]                          ········ 6u···b··
0010                                      "h····B· ····B···
0020                12 02 00 00 90 88 04  ······L· ········
```



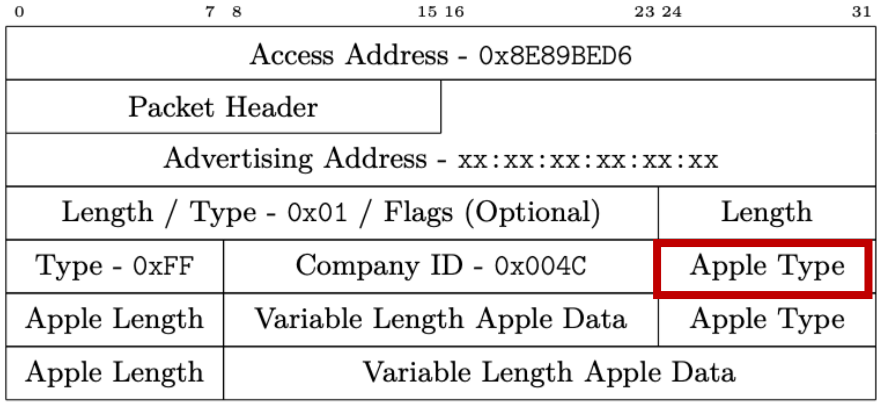
```
0000  [redacted]                          ········ 6u···b··
0010                                      ········ ·······{
0020                      10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                      R····
```



```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ······w· ····@··o
0020                                      0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d          ··q····\ ······
```

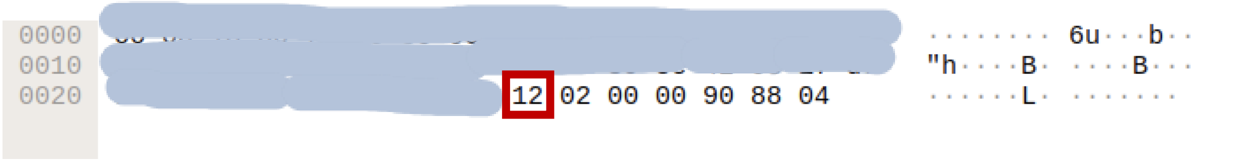
Continuity Protocol Explained

It's not a bug, it's a feature!

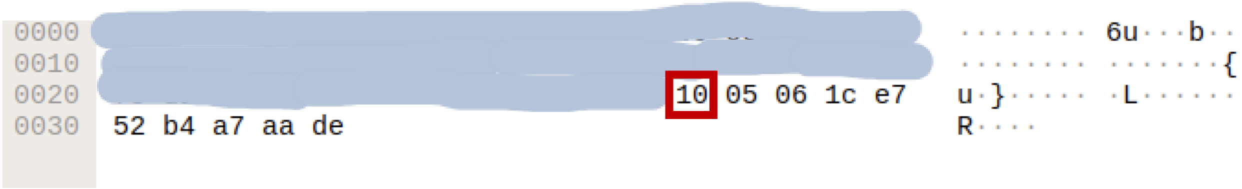


Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

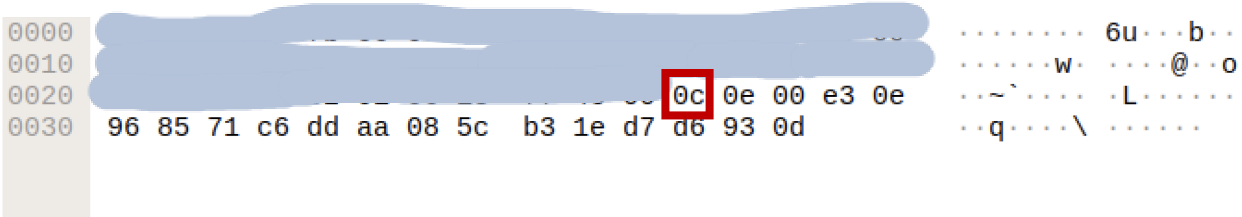
Apple BLE Frame Format



```
0000  [redacted]                              ········ 6u··b··
0010                                          "h···B·  ···B···
0020                        12 02 00 00 90 88 04   ······L· ·······
```



```
0000  [redacted]                              ········ ········ 6u··b··
0010                                          ········ ·······{
0020                        10 05 06 1c e7    u·}····· ·L······
0030  52 b4 a7 aa de                          R····
```



```
0000  [redacted]                              ········ 6u··b··
0010                                          ······w· ····@··o
0020                        0c 0e 00 e3 0e    ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d    ··q····\ ······
```

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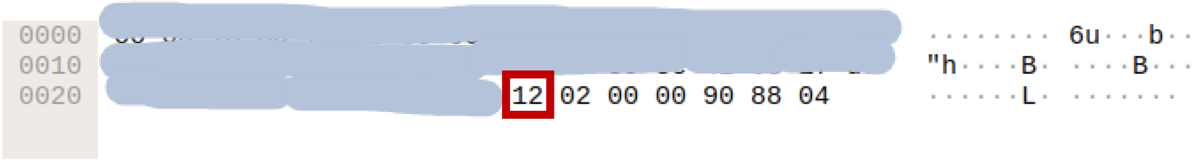
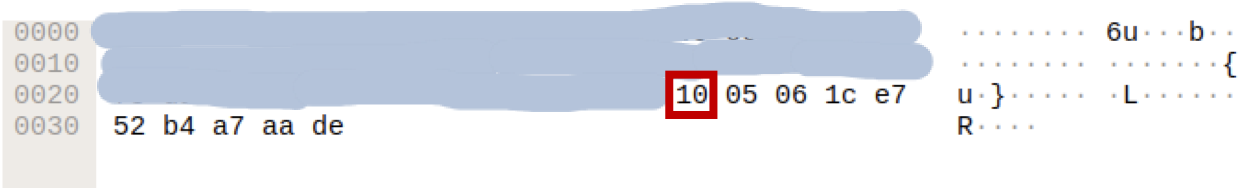
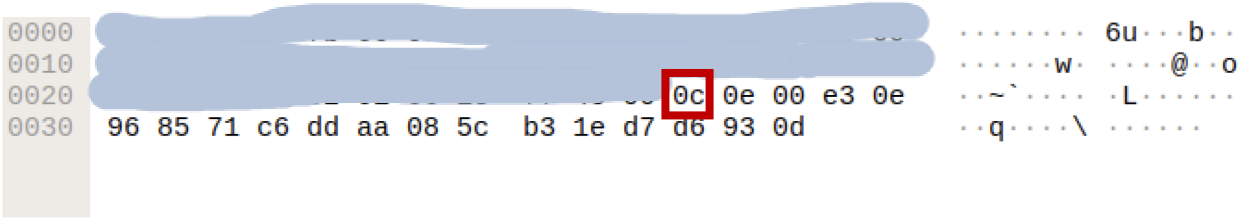
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12



```
0000                                                ········ 6u···b··
0010  [redacted]                                    "h····B· ····B···
0020                          12 02 00 00 90 88 04  ······L· ·······
```



```
0000                                                ········ 6u···b··
0010  [redacted]                                    ········ ·······{
0020                                 10 05 06 1c e7  u·}····· ·L······
0030  52 b4 a7 aa de                                 R····
```



```
0000                                                ········ 6u···b··
0010  [redacted]                                    ······w· ····@··o
0020                                0c 0e 00 e3 0e  ··~`···· ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d    ··q····\ ······
```

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Nearby Info	16	0x10
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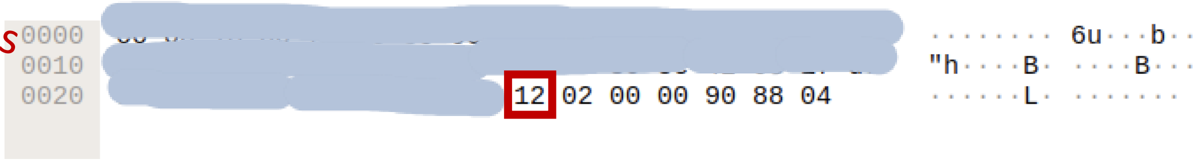
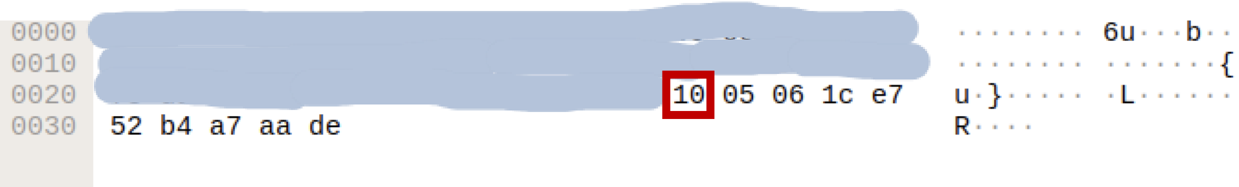
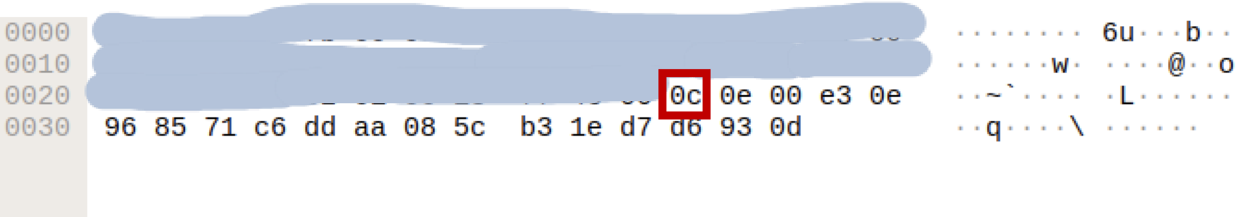
Apple Message Types



```
0000  [redacted]                                    ········ 6u···b··
0010  [redacted]                                    "h····B·  ····B···
0020  [redacted]           12 02 00 00 90 88 04     ······L·  ·······
```



```
0000  [redacted]                                    ········ 6u···b··
0010  [redacted]                                    ········ ·······{
0020  [redacted]                 10 05 06 1c e7     u·}····  ·L·····
0030  52 b4 a7 aa de                                R····
```



```
0000  [redacted]                                    ········ 6u···b··
0010  [redacted]                                    ······w·  ····@··o
0020  [redacted]                 0c 0e 00 e3 0e     ··~`····  ·L·····
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d    ··q····\  ······
```

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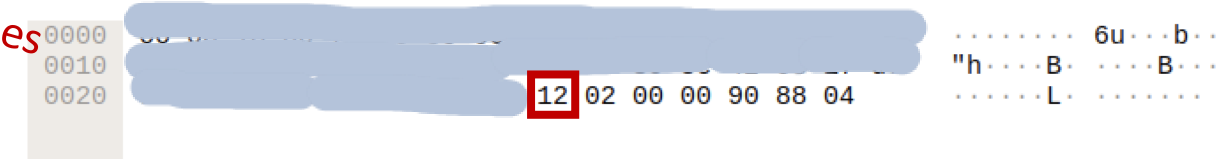
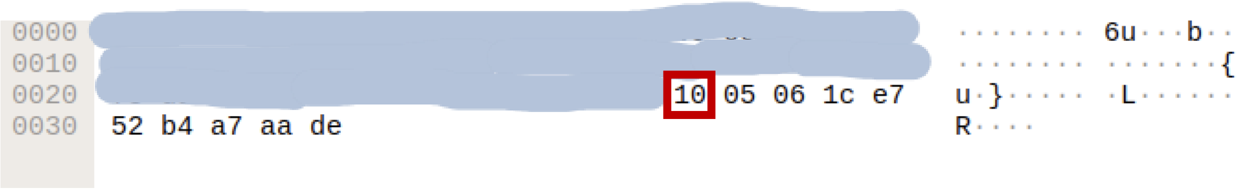
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12

Apple Message Types

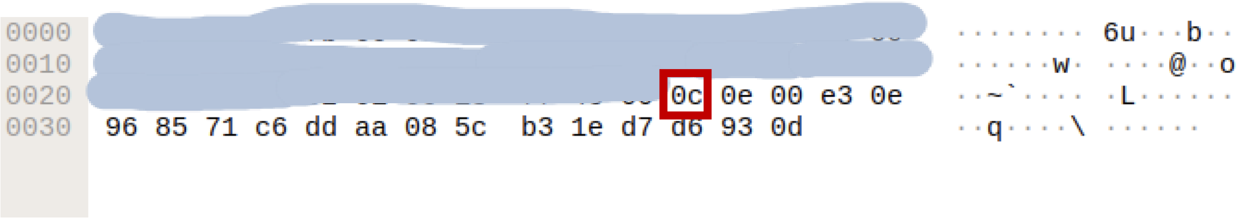


```
0000  [redacted]                              ········ 6u··b··
0010                                          "h···B·  ···B···
0020                      12 02 00 00 90 88 04 ······L· ·······
```

Type 18: Find My



```
0000  [redacted]                              ········ 6u··b··
0010                                          ········ ·······{
0020                          10 05 06 1c e7  u·}····· ·L·····
0030  52 b4 a7 aa de                          R····
```



```
0000  [redacted]                                     ········ 6u··b··
0010                                                 ······w· ····@··o
0020                                0c 0e 00 e3 0e   ··~`···· ·L·····
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d     ··q···\  ······
```

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It's not a bug, it's a feature!

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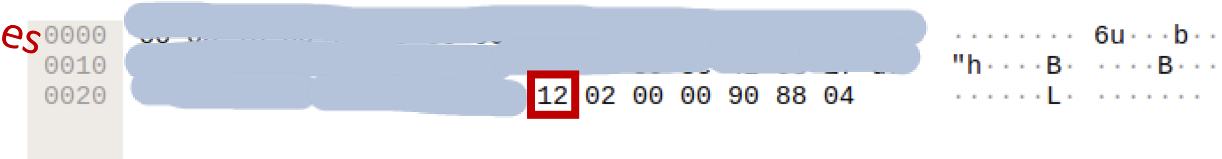
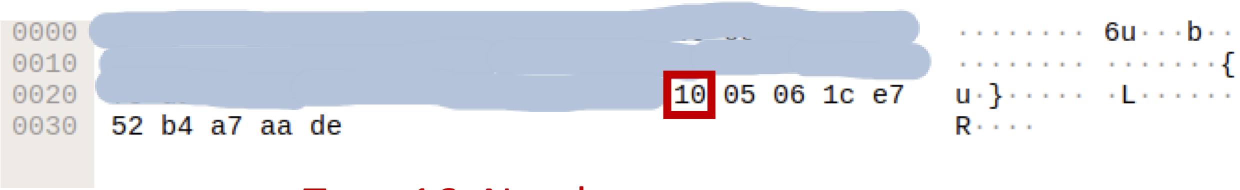
Instant Hotpot	14	0xfe
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12



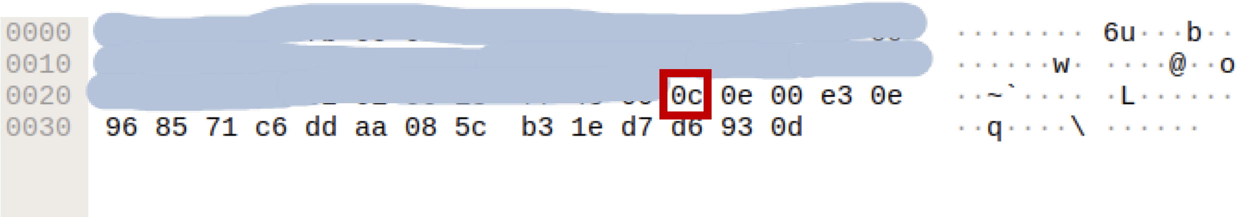
```
0000  [redacted]                                    ........ 6u..b..
0010                                                "h....B. ....B...
0020                          12 02 00 00 90 88 04  ......L. ........
```

Type 18: Find My



```
0000  [redacted]                                    ........ 6u..b..
0010                                                ........ .......{
0020                                10 05 06 1c e7  u.}..... .L......
0030  52 b4 a7 aa de                                R....
```

Type 16: Nearby



```
0000  [redacted]                                     ........ 6u..b..
0010                                                 ......w. ....@..o
0020                                0c 0e 00 e3 0e   ..~`.... .L......
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d     ..q....\ ......
```

Continuity Protocol Explained

It's not a bug, it's a feature!

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Handoff	12	0xc
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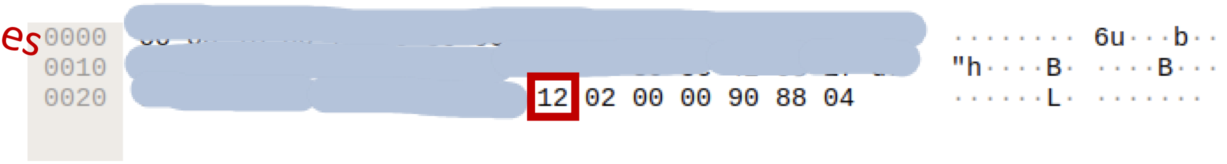
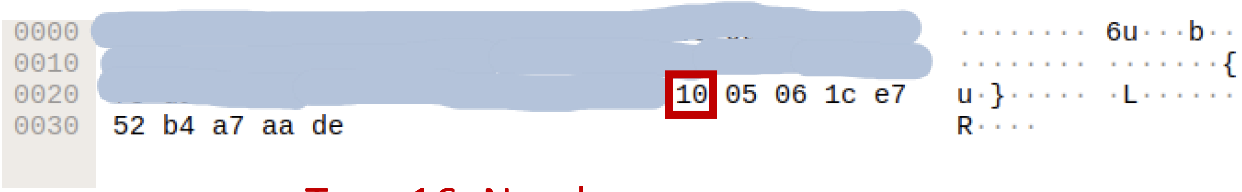
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12

Apple Message Types



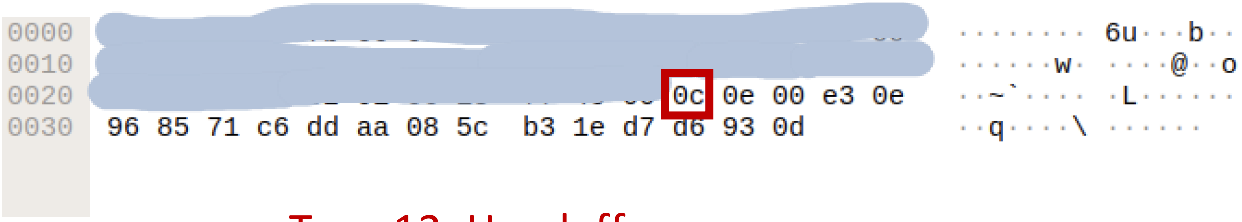
```
0000  [redacted]                                   ·········  6u···b··
0010                                               "h····B·   ····B···
0020                     12 02 00 00 90 88 04      ······L·   ·······
```

Type 18: Find My



```
0000  [redacted]                                   ·········  6u···b··
0010                                               ·········  ·······{
0020                          10 05 06 1c e7       u·}·····   ·L······
0030  52 b4 a7 aa de                               R····
```

Type 16: Nearby



```
0000  [redacted]                                   ·········  6u···b··
0010                                               ······w·   ····@··o
0020                          0c 0e 00 e3 0e       ··~`····   ·L······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d   ··q····\   ······
```

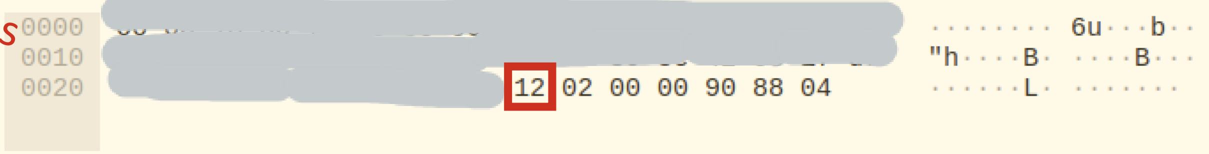
Type 12: Handoff

Continuity Protocol Explained

It’s not a bug, it’s a feature!

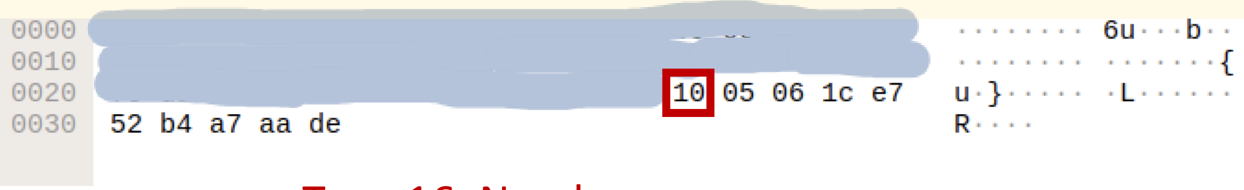
Message Type	Dec Value	Hex Value
AirDrop	5	0x05
Proximity Pairing	7	0x07
Hey Siri	8	0x08
Magic Switch	11	0xb
Handoff	12	0xc
Instant Hotpot	14	0xfe
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12

Apple Message Types



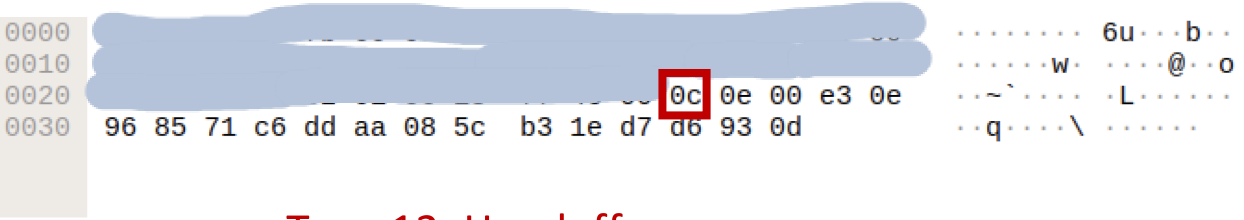
```
0000  [redacted]                                  ········· 6u···b··
0010                                              "h····B·  ····B···
0020                     12 02 00 00 90 88 04     ·······L· ········
```

Type 18: Find My



```
0000  [redacted]                                  ········· 6u···b··
0010                                              ········· ········{
0020                         10 05 06 1c e7       u·}·····  ·L·······
0030  52 b4 a7 aa de                              R····
```

Type 16: Nearby



```
0000  [redacted]                                  ········· 6u···b··
0010                                              ······w·  ····@··o
0020                         0c 0e 00 e3 0e       ··~`····  ·L·······
0030  96 85 71 c6 dd aa 08 5c  b3 1e d7 d6 93 0d  ··q····\ ·······
```

Type 12: Handoff

AirTags Explained

AirTag

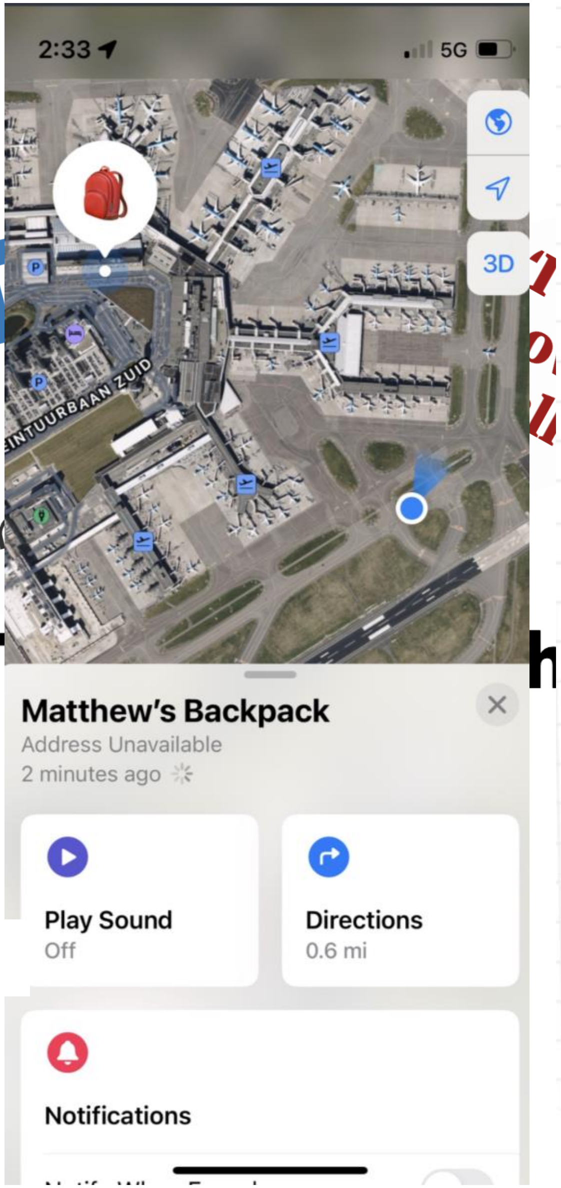
AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband

@mattbenyo

TECHNOLOGY

AirTags
and ca

AirT
can



Matthew's Backpack
Address Unavailable
2 minutes ago

Play Sound
Off

Directions
0.6 mi

Notifications

ELECTRONIC FRONTIER FOUNDATION
EFF
season 2
EXPERT INTERVIEW SERIES
finale!
but this announcement made stalking more accessible
THE PRIVACY PARADOX
FEAT. ALEXIS HANCOCK

dian
ne':
ift to

Offline Finding Explained

It’s not a bug, it’s a feature!

In 5 Minutes

Offline Finding Explained

It’s not a bug, it’s a feature!

Ultra Wideband • AirTag • Designed by Apple in California • Assembled in China
Bluetooth LE •

No GPS!

Offline Finding Explained

It's not a bug, it's a feature!

AirTag • Designed by Apple in California • Assembled in China
Bluetooth LE • Ultra Wideband

No GPS!

..so how does it work?

Offline Finding Explained

It’s not a bug, it’s a feature!

Asymmetric Encryption 101

PUBLIC KEY = encrypt
PRIVATE KEY = decrypt

Offline Finding Explained

It’s not a bug, it’s a feature!

AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband

Offline Finding Explained

It’s not a bug, it’s a feature!

AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband

airtag

Offline Finding Explained

It’s not a bug, it’s a feature!

No GPS but… BLUETOOTH!

AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband

airtag

Offline Finding Explained

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No GPS but… BLUETOOTH!

Bluetooth LE • Ultra Wideband • AirTag • Designed by Apple in California • Assembled in China

airtag

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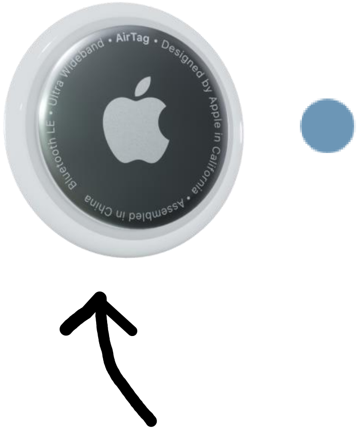
Bluetooth LE • Ultra Wideband • AirTag • Designed by Apple in California • Assembled in China

airtag

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No GPS but… BLUETOOTH!

AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband

0x12345678910ABCDEFABCDEF

airtag

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AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE • Ultra Wideband •

0x12345678910ABCDEFABCDEF

airtag

Notional key PubKey

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Ultra Wideband • AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE •

0x12345678910ABCDEFABCDEF

airtag

Notional key PubKey

P224 ELLIPTIC CURVE PUBLIC KEY
224 bits in PubKey = 28 byte key

Offline Finding Explained

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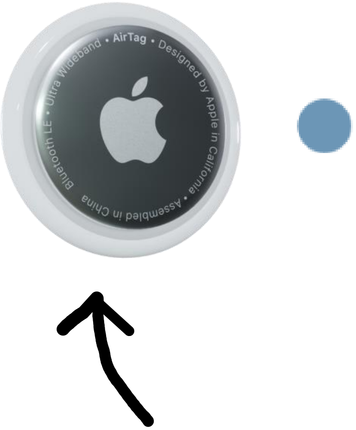
No GPS but… BLUETOOTH!



PubKey

airtag

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Ultra Wideband • AirTag • Designed by Apple in California • Assembled in China • Bluetooth LE •

PubKey

airtag

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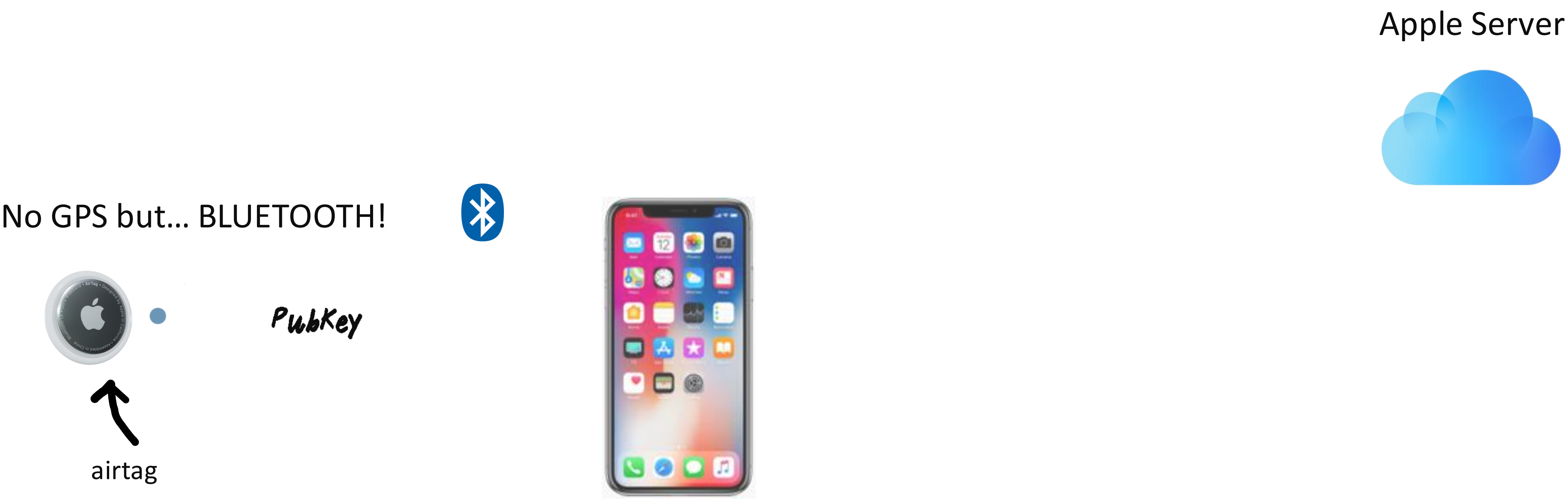

Apple Server

No GPS but… BLUETOOTH!

PubKey

airtag

Offline Finding Explained

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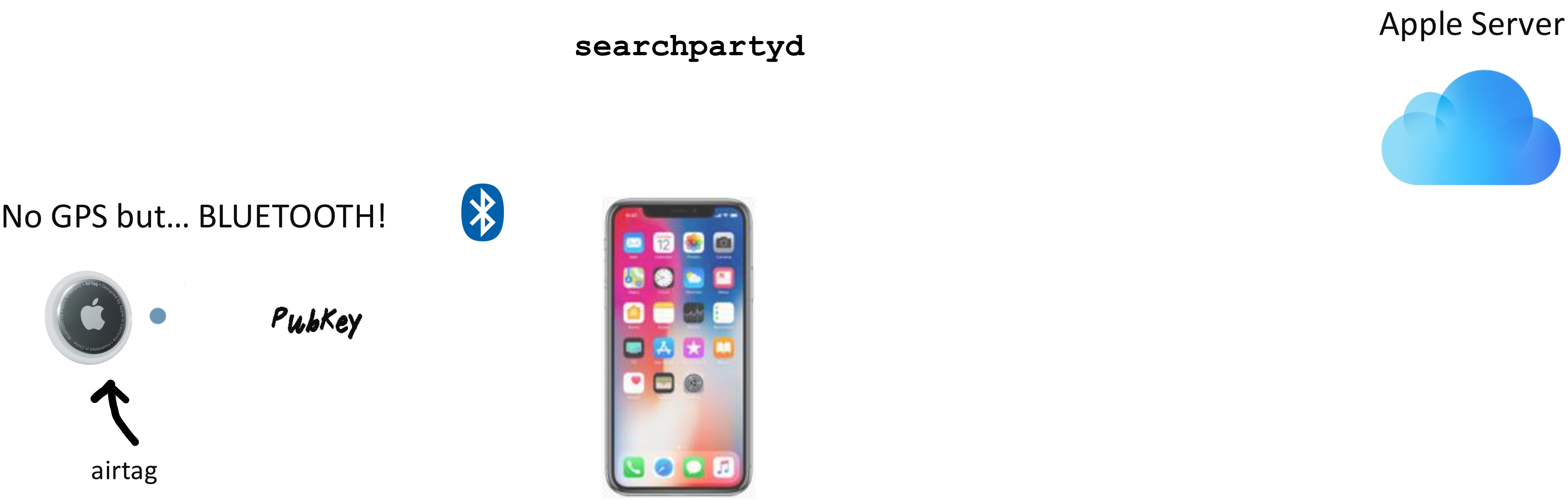

searchpartyd

Apple Server

No GPS but… BLUETOOTH!

Offline Finding Explained

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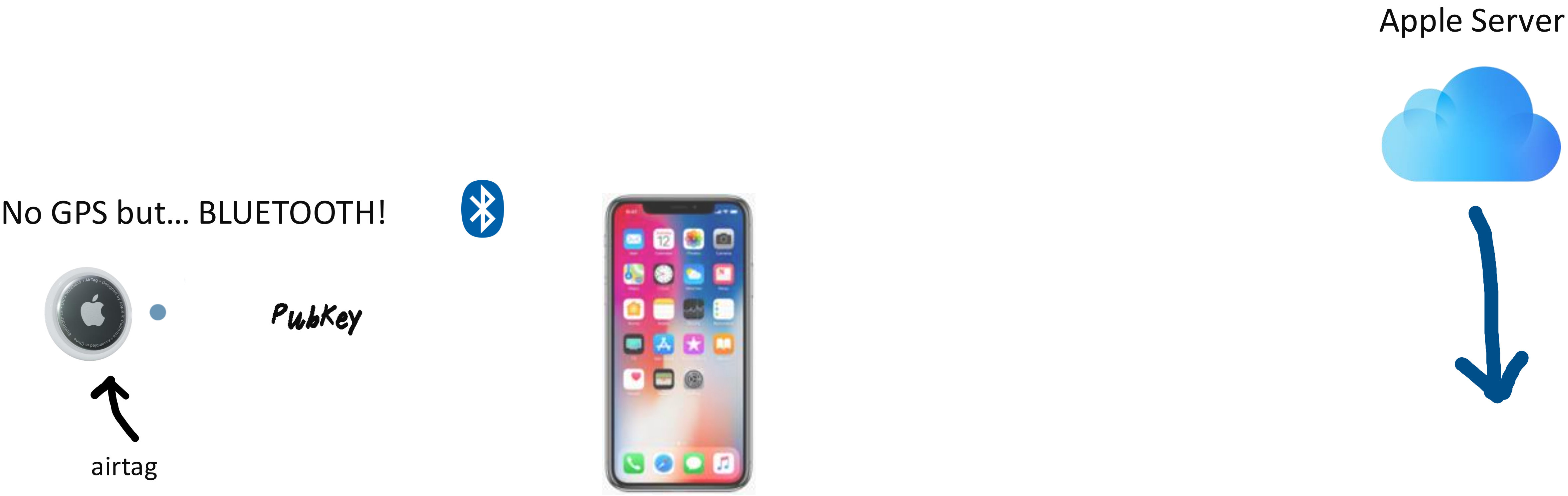

Apple Server

No GPS but… BLUETOOTH!

PubKey

airtag

Offline Finding Explained

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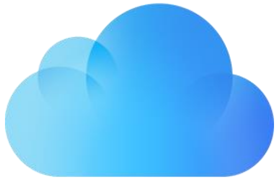
No GPS but… BLUETOOTH!

airtag

PubKey

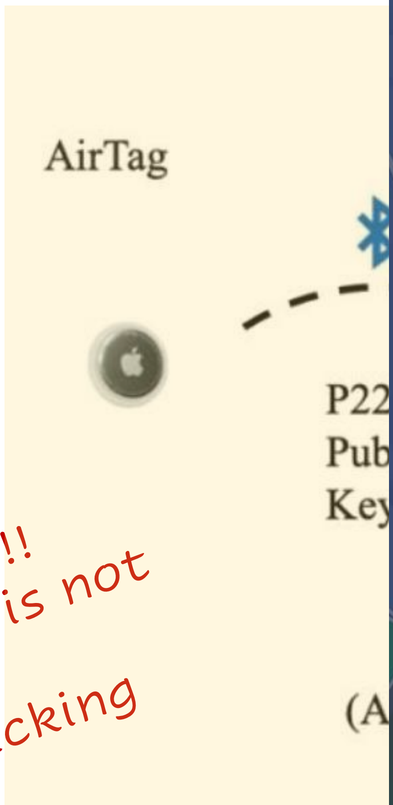
Apple Server



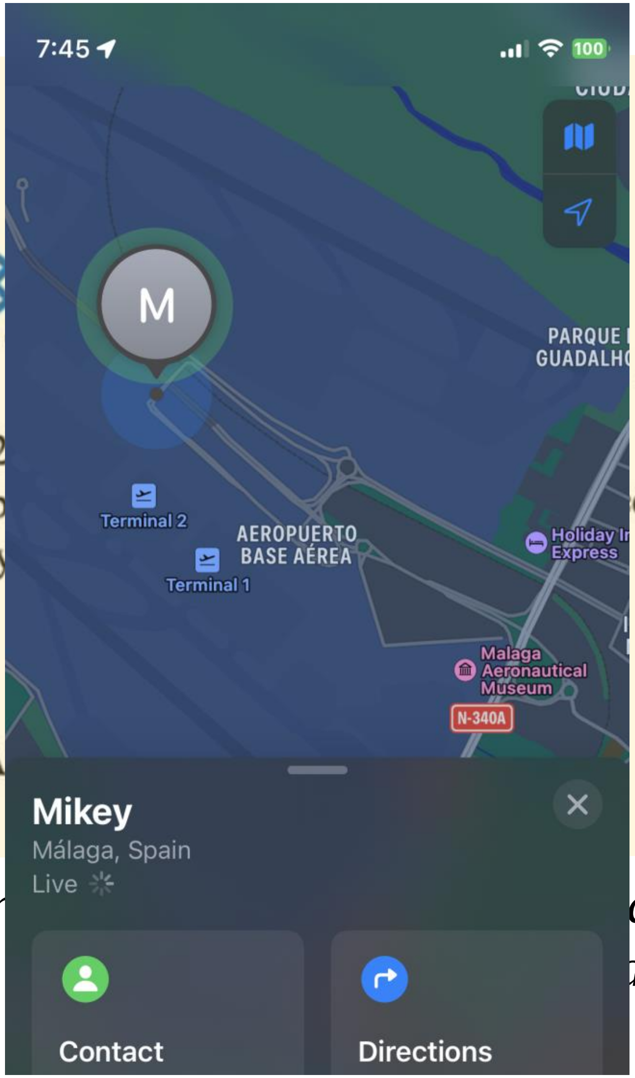
Can download and unlock with Private Key

Offline Finding Explained

It’s not a bug, it’s a feature!



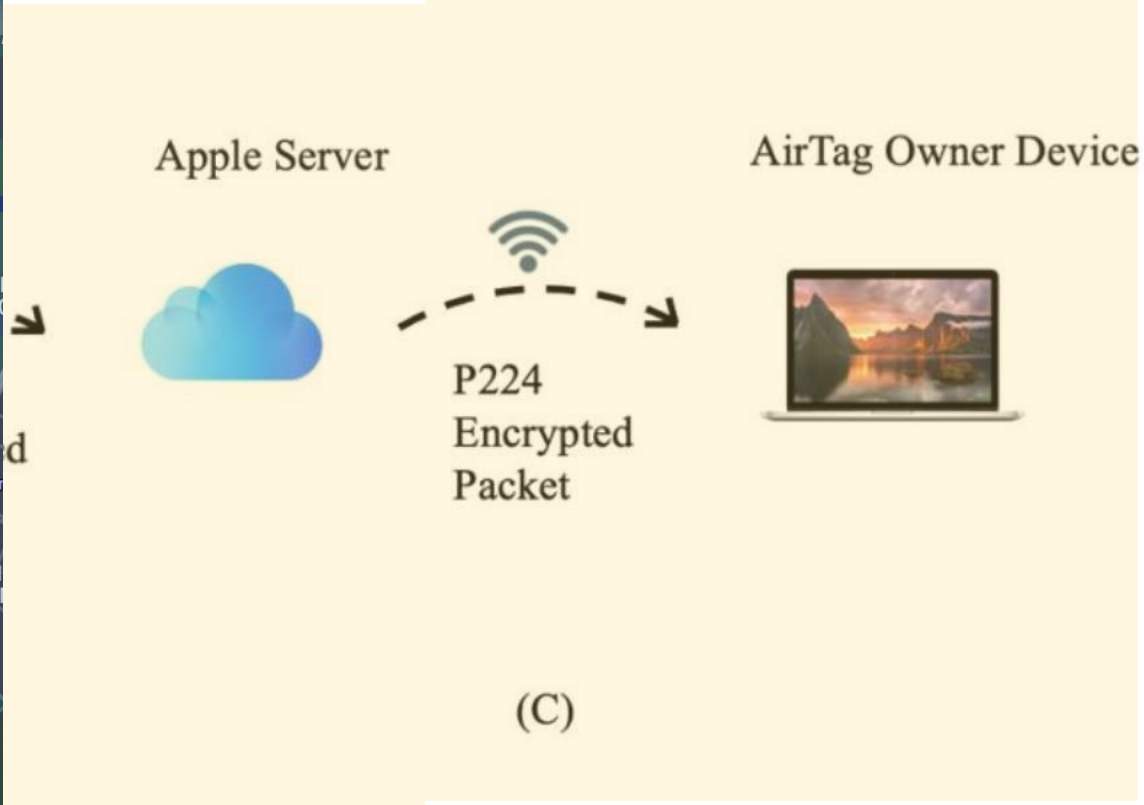
NOTE!!
This is not
live
tracking



Mikey

Málaga, Spain

Live



If at 3:00pm or … *arby to a user who claimed they were at the Hilton Hotel, then the* … *at or near the Hilton Hotel at the same time.*

What the heck is P224- ECIES?!

- Let’s take a deep dive into encryption (photo cred @replover4eva)

P-224 Encryption in General

- Recall the Diffie Hellman key exchange, and the ability to generate a shared secret
- P-224 Elliptic Curve Diffie Hellman (ECDH) is similar, with more parameters

The “domain parameters” are already agreed upon (p, a, b, G, n, h) and the curve is represented by the formula:

y^2= x^3-3x+18958286285566608000408668544493926415504680968679321075787234672564

and (p, a, b, G, n, h) are defined as follows:

p = 26959946667150639794667015087019630673557916260026308143510066298881

a = -3

b = 18958286285566608000408668544493926415504680968679321075787234672564

G= (19277929113566293071110308034699488026831934219452440156649784352033,
19926808758034470970197974370888749184205991990603949537637343198772)

n = 26959946667150639794667015087019625940457807714424391721682722368061

h=1

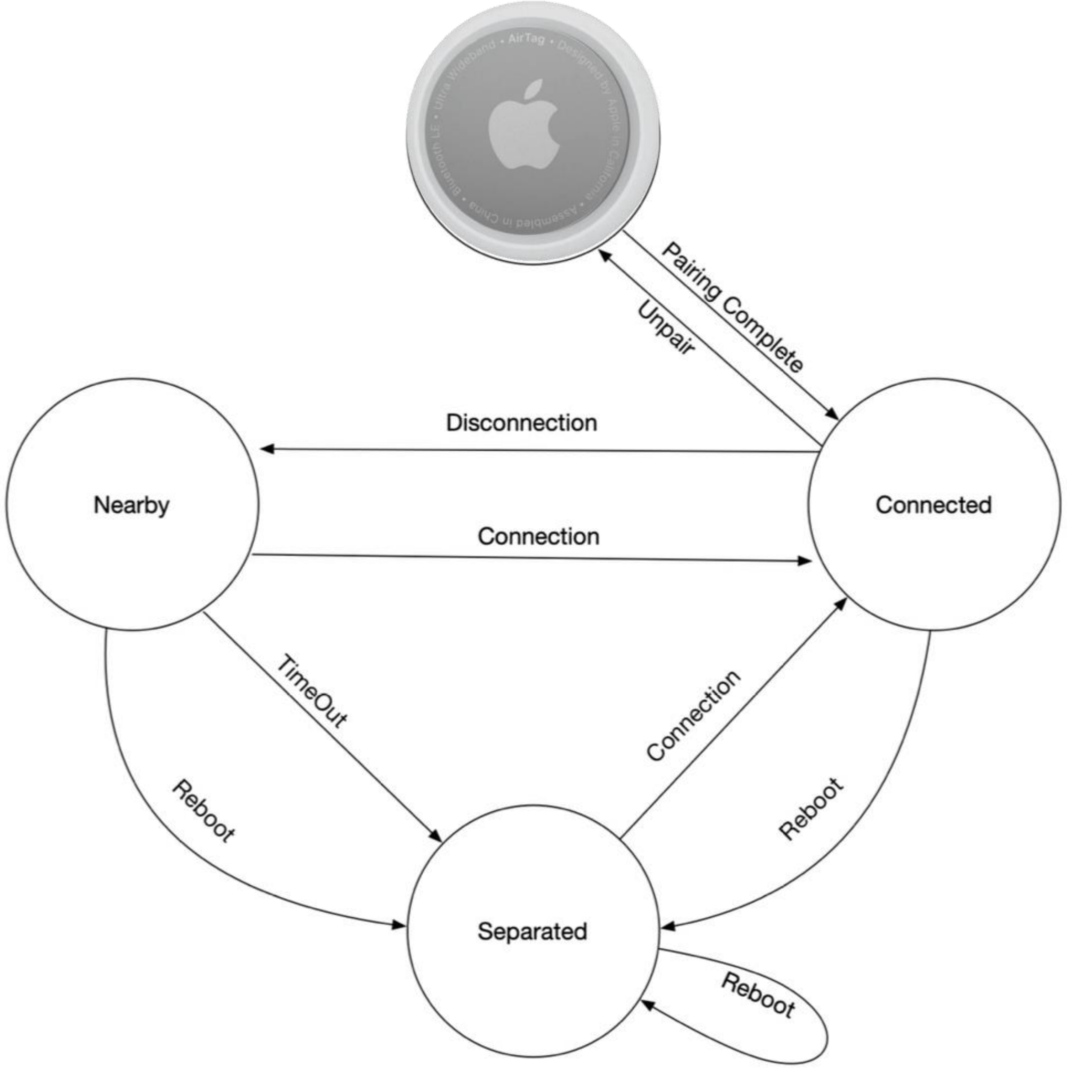
(FIPS 186-4 Digital Standard)

P-224 ECIES

- “Elliptic Curve Integrated Encryption Scheme”
- This is introduced in a 2009 paper (Daniel R. L. Brown. Standards for Efficient Cryptography 1 (SEC 1). 2009. https://www.secg.org/sec1-v2.pdf)
- Supposed to be Even More Secure™ and protect against chosen-plaintext and chosen-ciphertext attacks
- ECIES integrates additional features such as message authentication codes (MAC) and key derivation functions (KDF) into the protocol, as well as a symmetric encryption scheme for faster encryption times

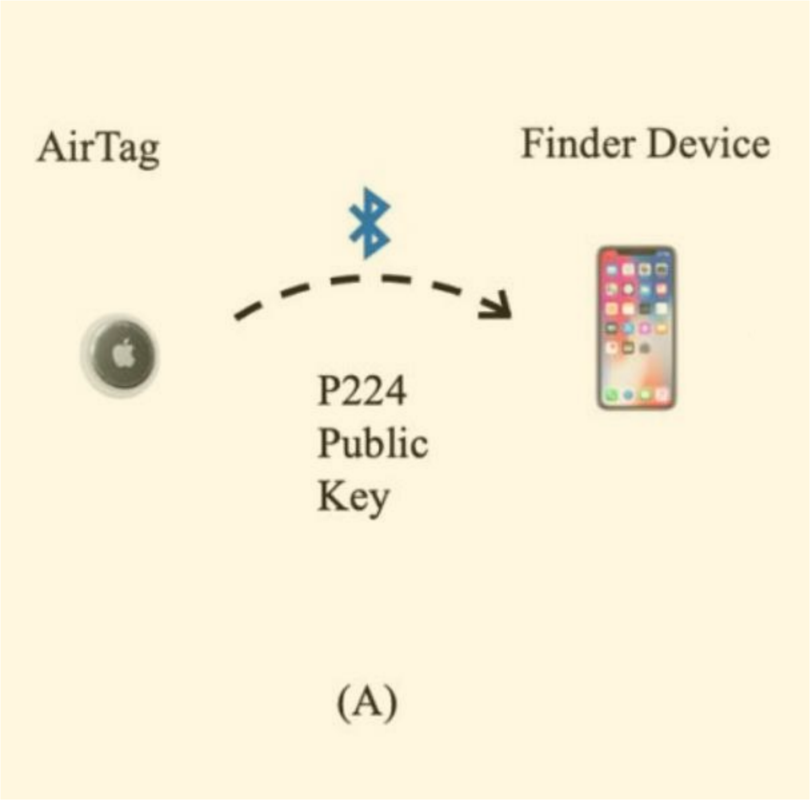
- In the AirTag implementation, the KDF used is ANSI-X9.63-KDF and the MAC scheme used is SHA-256. The symmetric key scheme ENC is AES-128-GCM.
- It is important to note that given an elliptic curve and an x-coordinate on that curve, the y-coordinate can be trivially calculated, so usually only the x-coordinate is shared in practical implementations

The State Machine of the AirTag



Continuity Protocol Explained

It's not a bug, it's a feature!



The AirTag and owner device must collaboratively generate a 28 byte Master key P, (comprised of key pair public p_0 and private d_0) as well a 32 byte key Secret Key Separated (SKS)

(basically, they use math to each generate P without either actually sending P over the channel, much like most shared secret generation)

AirTag + Owner Device Key Exchange

- Assume an a priori securely established Bluetooth communications channel (During the Bluetooth pairing procedure, the two devices use an a priori Apple server key (written into the firmware of both devices) [12]to encrypt these initial transmissions)
- Collaborative Key Generation Steps (From the Original FindMy Specification)
  - "AirTag Accessory Alice" must generate a P-224 scalar *s* and a random 32 byte value *r*, then concatenates *s* with *r*, and calculates a value *c1* by calculating the SHA-256 of *s* concatenated with *r*.
  - "Owner Device Bob" also generates a P-224 scalar, *s'*, and a random 32 byte value *r'*. However, Bob then uses generational point *G* to generate *S'*, where *S' = G * s'*, where * indicates the dot product. Bob's iDevice can then send *c2* which is a set containing {S', r'}.
  - Now, S' is also point on the curve P-224, because it was created from G, the generational point. AirTag Accessory Alice verifies this. The AirTag will be the first to compute the Master public key P. Using S' from the Owner device, the formula is P = S' +s * G. Remember, P is never sent over the channel, so instead, the AirTag sends *c3* = {s, r}

AirTag + Owner Device Key Exchange (cont)

- Collaborative Key Generation Steps (cont)
  - Next, the owner device does a bit of verification, first, verifying that s is a valid P-224 scalar, and then computing the SHA-256 hash of s concatenated with r. The AirTag sent this value initially with c1, so the owner device compares its own calculation to c1, and aborts if they are not equal. Now, the owner device can independently compute the Master key P with the formula P = S' +s * G and the private key d with the formula d = s +s'(mod q), where q is the order of the base point G of the P-224 elliptic curve.
  - At this point, the AirTag and the owner device (Alice and Bob) each have generated P without sending it over the channel. Using P, each can independently compute SKN and SKS as the 64 byte output of the KDF function ANSI-X9.63-KDF(x(P), r concatenated with r'). The SKN is the first 32 bytes of this value and SKS the last 32 bytes.

Continuity Protocol Explained

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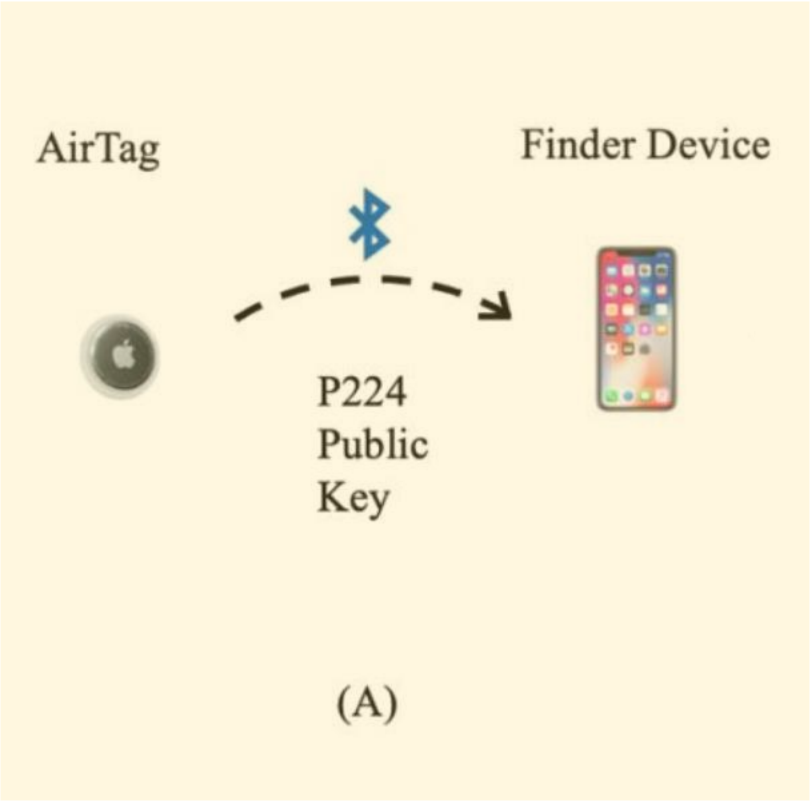


The AirTag and owner device must collaboratively generate a 28 byte Master key P, (comprised of key pair public p_0 and private d_0) as well a 32 byte key Secret Key Separated (SKS)

The master key P and SKS are used to generate a derivative key PW_i, defined by key pairs public p_i and private d_i

Every 15 minutes, a new key pair public p_i and private d_i are generated, and the new p_i value is what is beaconed

All the math

1) ephemeral key is generated (extraction)

SKS_i = KDF(SKS_{i-1}, “update”, 32)

2) expansion of key pair

(u_i , v_i) = KDF(SKS_i , “diversify”, 72)

3) Reduce into P-224 valid scalars

$u_i = u_i \pmod{q-1} + 1$ (where q is the order of the base point G of the P-224 elliptic curve.)

$v_i = v_i \pmod{q-1} + 1$

4)Generate p_i and d_i

$d_i = (d_0 * u_i) + v_i$

$p_i = (d_i * G)$

Where * is the dot product, G is the point generator and the original key pair is (d_0,p_0)

Continuity Protocol Explained

It's not a bug, it's a feature!

Finde

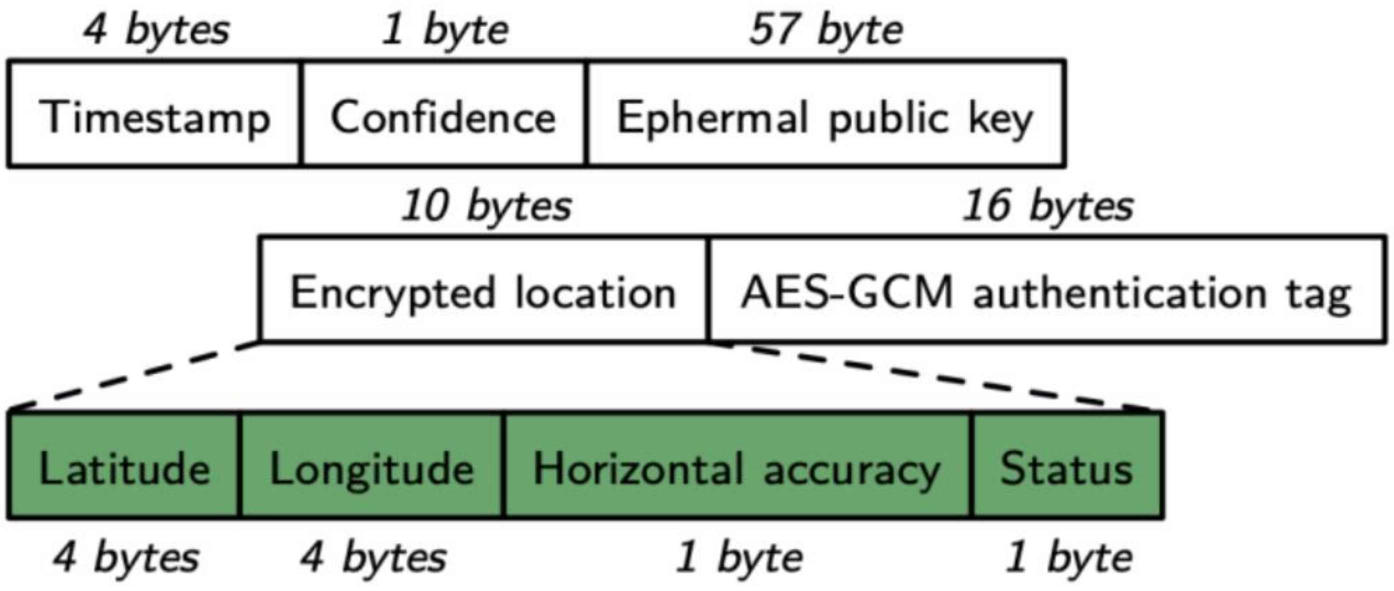


Fig. 2. Binary format of a location report.

(from TU Darmstadt paper, Alex Heinrich + Milan Stute)

s its own ephemeral key

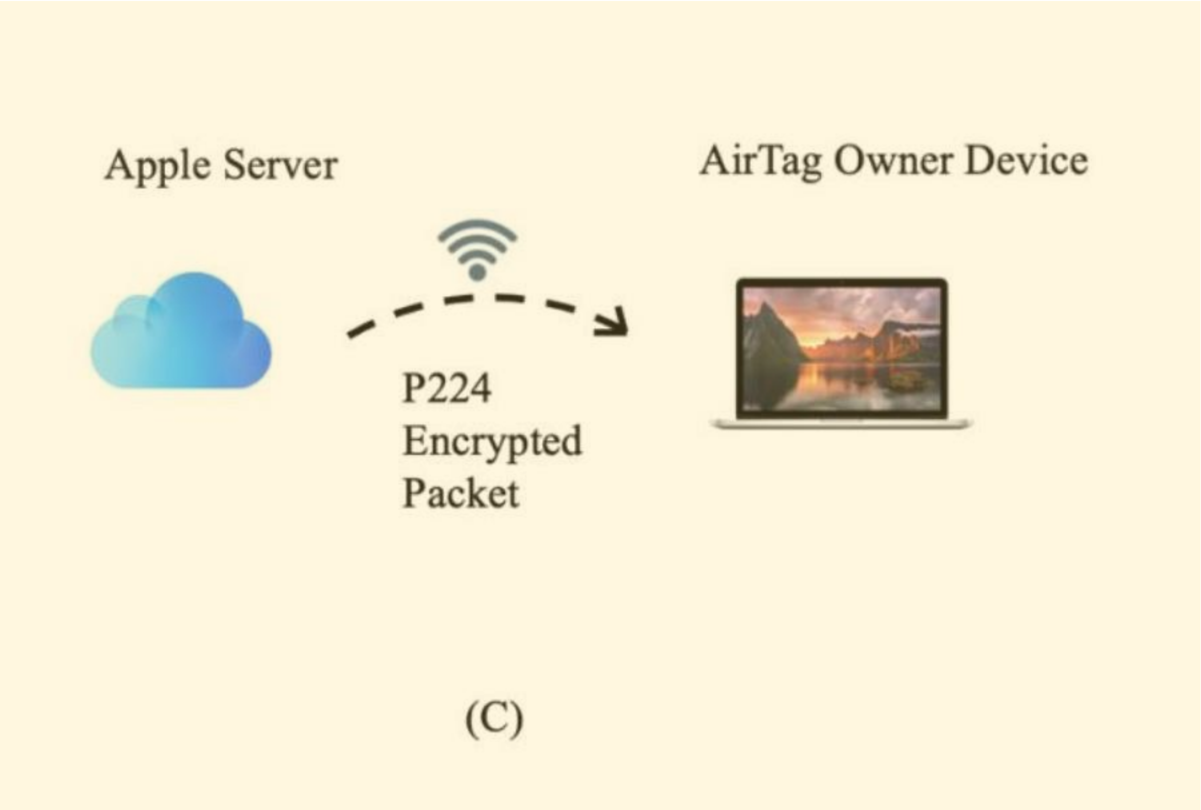
ey p_i, it uses ECDH to
et –> SharedKeyFinder

n ephemeral key
`e", 32)`

come a 16 byte
CM. The last 16 bytes of
n vector (IV). This is an

Continuity Protocol Explained

It’s not a bug, it’s a feature!

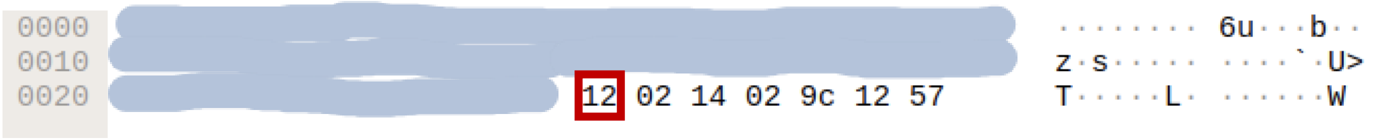


- The Apple Servers store the locations reports as key value pairs (SHA256(p_i), 88 byte location report)
- You can request a location report as long as you know the hash
- The owner device collaboratively generated (p_0,d_0), so calculating p_i and SHA256(p_i) is trivial.
- Also, because the owner device can recalculate all of the private keys from the airtag as well, it will calculate the corresponding private key d_i for public key p_i, then using the ephemeral public key , the owner can calculate the shared secret SKF. Using the known KDF function, the owner can then calculate SKF’, which becomes e’ and IV, and was used to AES- 128 encrypt the original payload, and since AES is symmetric, this will decrypt that location report as well.

Continuity Protocol Explained

It’s not a bug, it’s a feature!

Message Type	Dec Value	Hex Value
AirDrop	5	0x05
Proximity Pairing	7	0x07
Hey Siri	8	0x08
Magic Switch	11	0xb
Handoff	12	0xc
Instant Hotpot	14	0xfe
Nearby Action	15	0xff
Nearby Info	16	0x10
FindMy	18	0x12

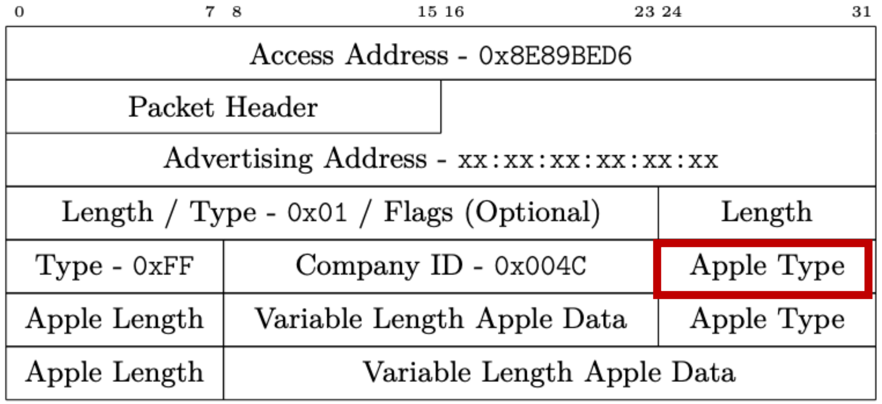


```
0000  [redacted]                                  ········ 6u···b··
0010                                              z·s····· ····`·U>
0020  [redacted]     12 02 14 02 9c 12 57         T·····L· ······W
```

Type 18: Find My

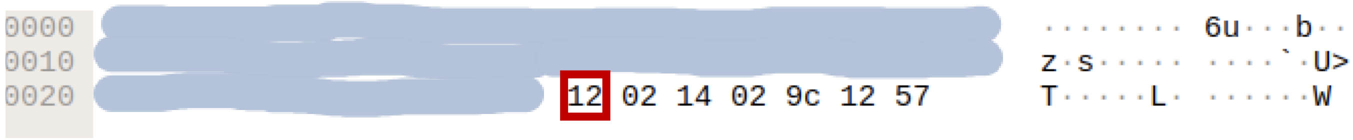
Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                              ········ 6u···b··
0010                                          z·s····· ····`·U>
0020                 12 02 14 02 9c 12 57     T·····L· ······W
```

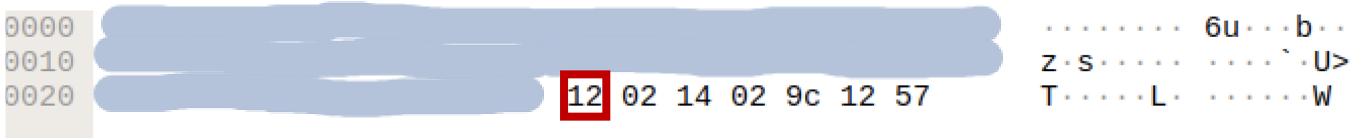
Type 18: Find My

Continuity Protocol Explained

It's not a bug, it's a feature!

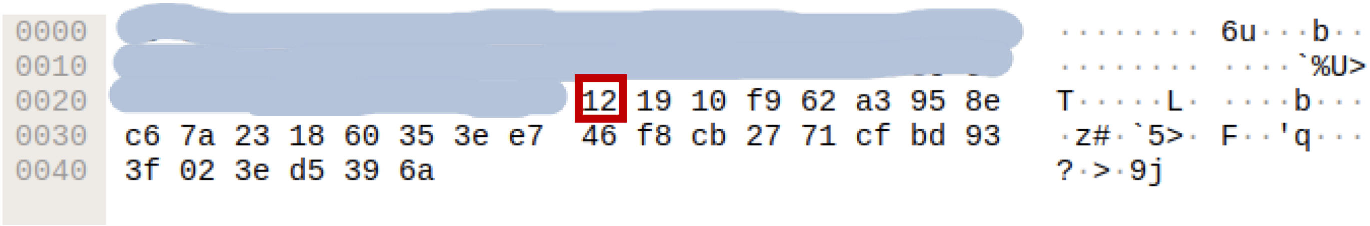
0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                 ········ 6u···b··
0010                                            z·s····· ····`·U>
0020                     12 02 14 02 9c 12 57   T·····L· ······W
```

Type 18: Find My

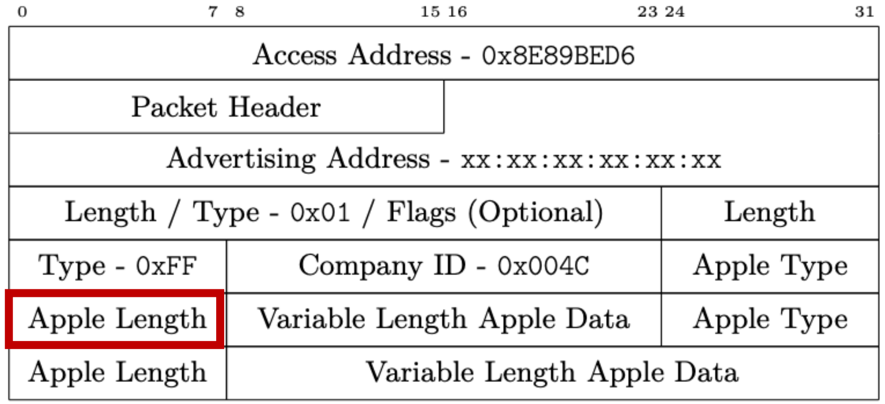


```
0000 [redacted]                                         ········ 6u···b··
0010                                                    ········ ····`%U>
0020                     12 19 10 f9 62 a3 95 8e        T·····L· ····b···
0030 c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93    ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                                  ?·>·9j
```

Type 18: Find My

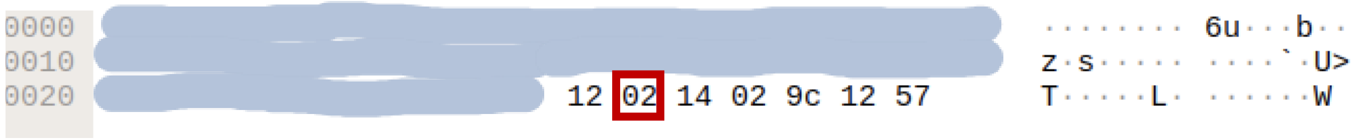
Continuity Protocol Explained

It’s not a bug, it’s a feature!

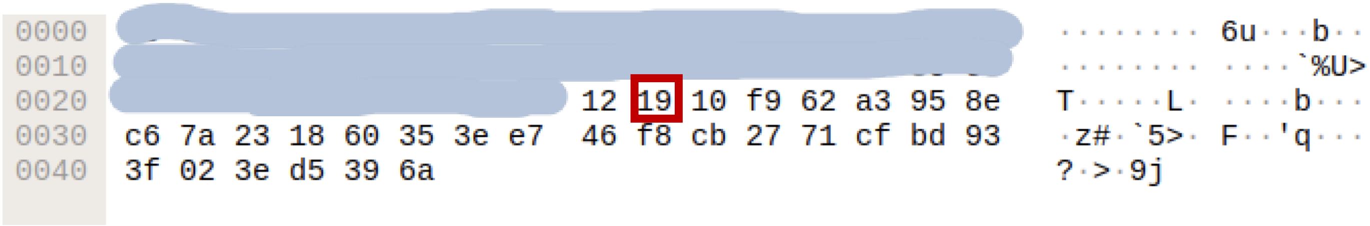


0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                      ········ 6u···b··
0010                                                  z·s····· ····`·U>
0020                        12 02 14 02 9c 12 57      T·····L· ······W
```



```
0000  [redacted]                                      ········ 6u···b··
0010                                                  ········ ····`%U>
0020                        12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93 ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                               ?·>·9j
```

Continuity Protocol Explained

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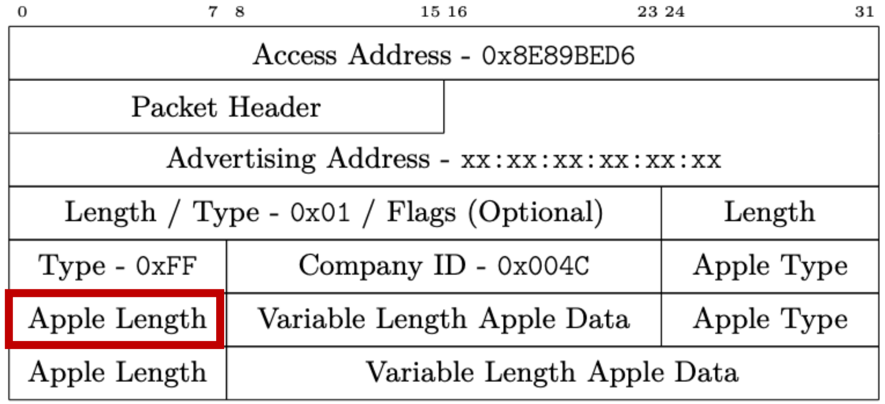
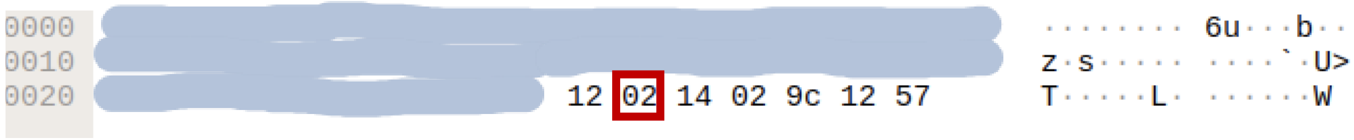
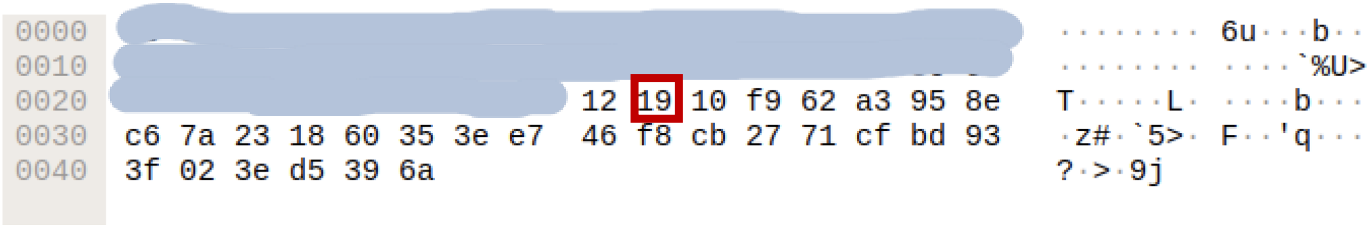

0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

Apple BLE Frame Format



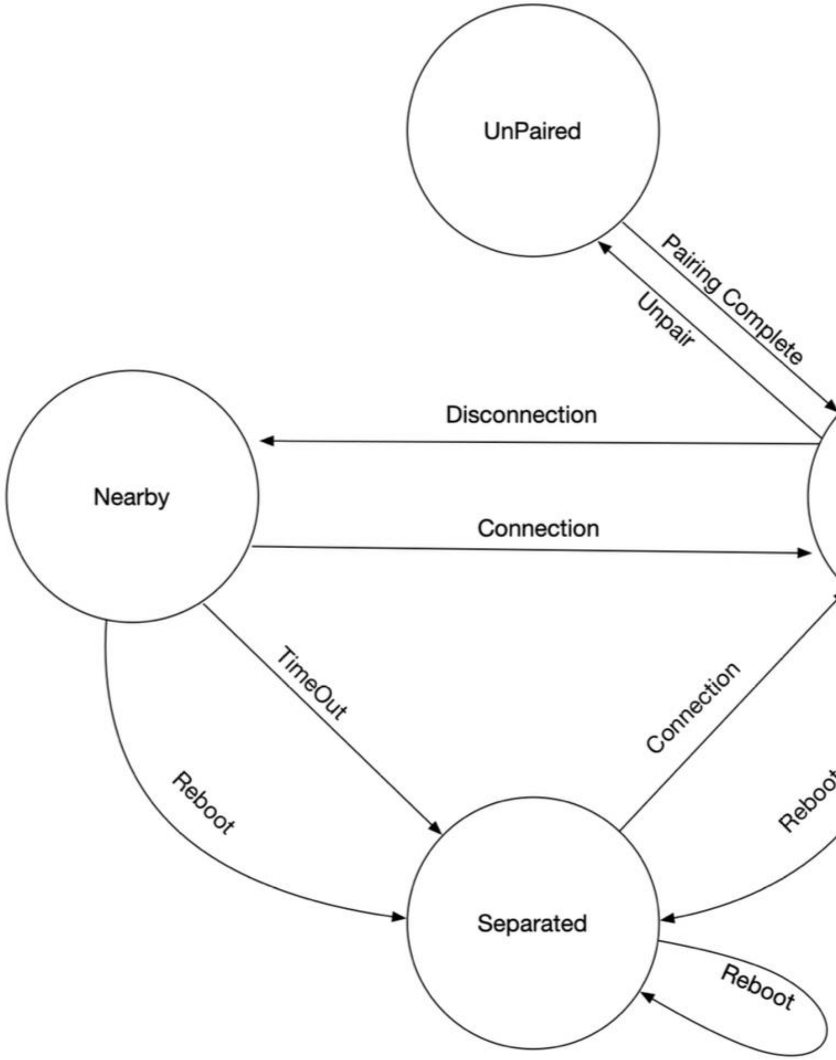
```
0000  [redacted]                                 ········  6u···b··
0010  [redacted]                                 z·s·····  ····`·U>
0020  [redacted]              12 02 14 02 9c 12 57   T·····L·  ······W
```



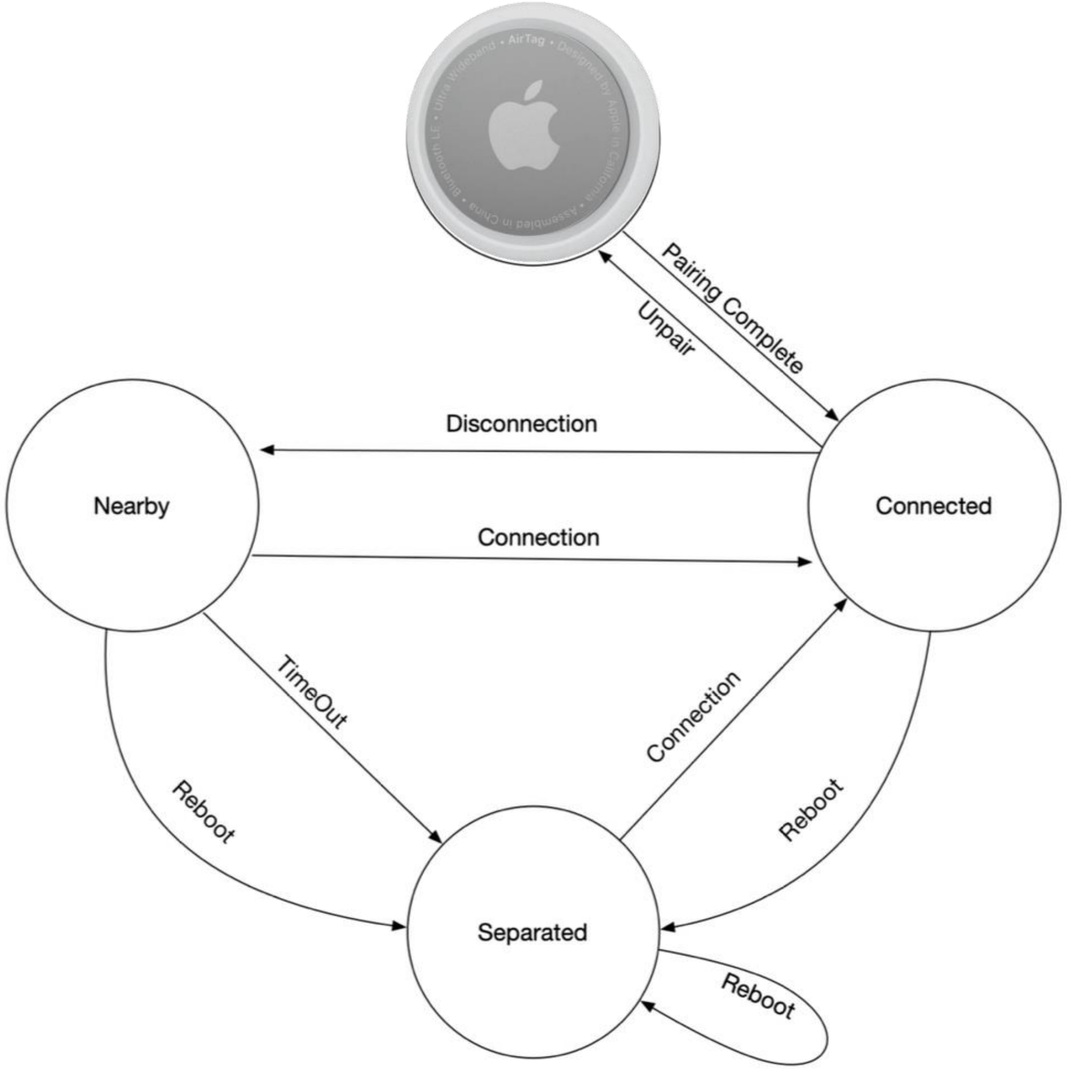
```
0000  [redacted]                                         ········  6u···b··
0010  [redacted]                                         ········  ····`%U>
0020  [redacted]              12 19 10 f9 62 a3 95 8e    T·····L·  ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·  F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

PAUSE: WHY ARE THESE DIFFERENT?!

The State Machine of the AirTag



The State Machine of the AirTag



Continuity Protocol Explained

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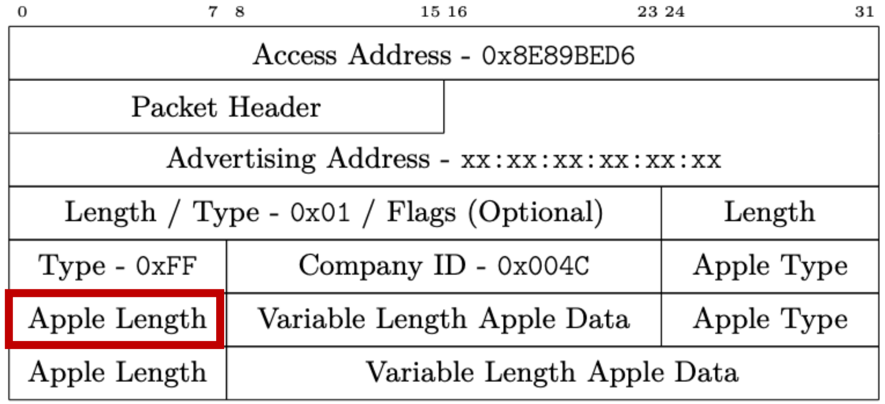


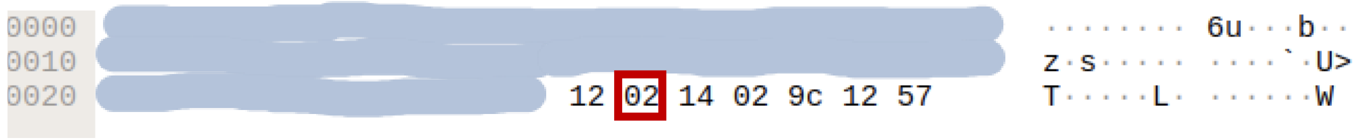
Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

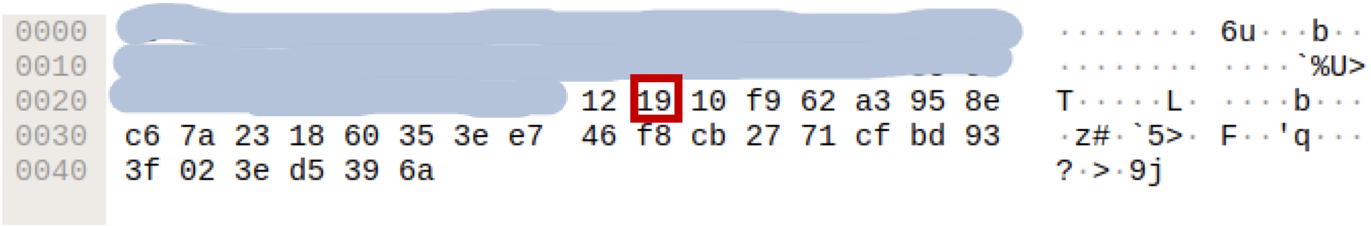
Length / Type - 0x01 / Flags (Optional)		Length
Type - 0xFF	Company ID - 0x004C	Apple Type
Apple Length	Variable Length Apple Data	Apple Type
Apple Length	Variable Length Apple Data	

Apple BLE Frame Format



```
0000 [redacted]                                  ········ 6u···b··
0010 [redacted]                                  z·s····· ····`·U>
0020 [redacted]             12 02 14 02 9c 12 57 T·····L· ······W
```

Nearby



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0010 [redacted]                                          ········ ····`%U>
0020 [redacted]                 12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                                   ?·>·9j
```

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Continuity Protocol Explained

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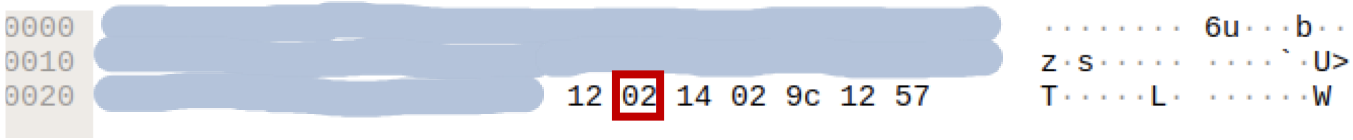
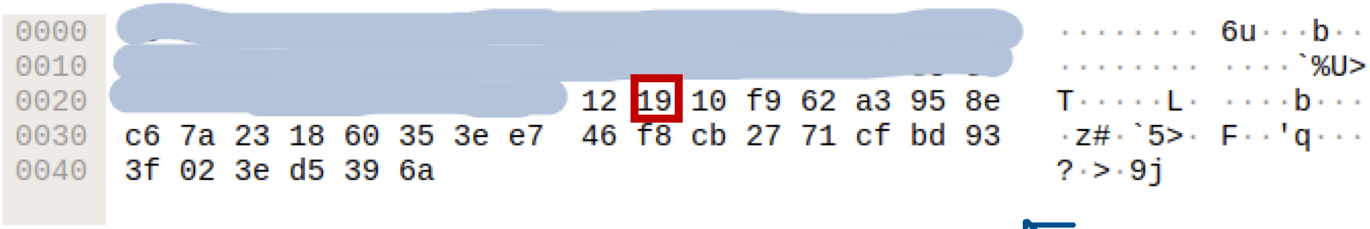
0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                     ········ 6u···b··
0010                                                 z·s····· ····`·U>
0020                           12 02 14 02 9c 12 57  T·····L· ······W
```

Nearby



```
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0010                                                    ········ ····`%U>
0020                             12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated

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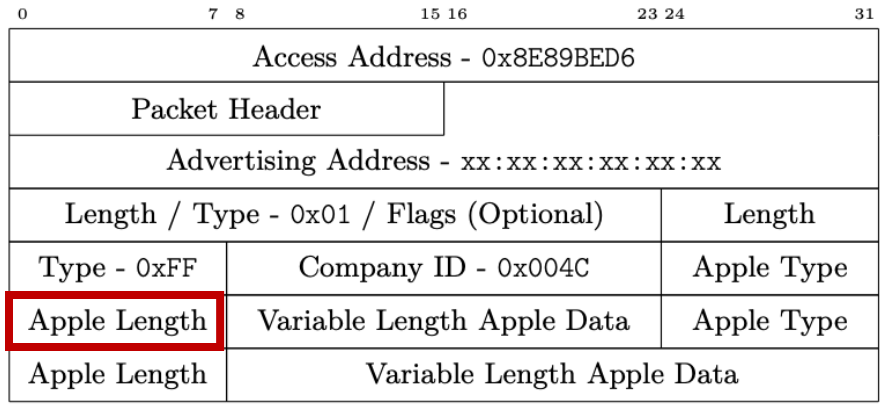

<table>
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<tr><td colspan="4">Access Address - 0x8E89BED6</td></tr>
<tr><td colspan="2">Packet Header</td><td colspan="2"></td></tr>
<tr><td colspan="4">Advertising Address - xx:xx:xx:xx:xx:xx</td></tr>
<tr><td colspan="3">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
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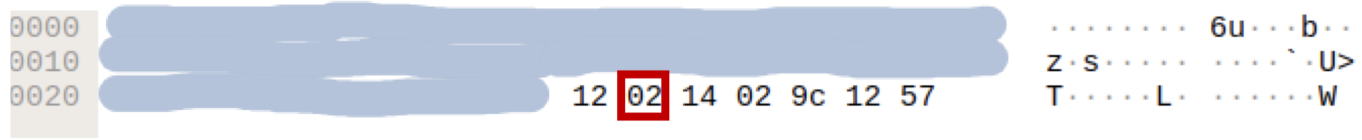
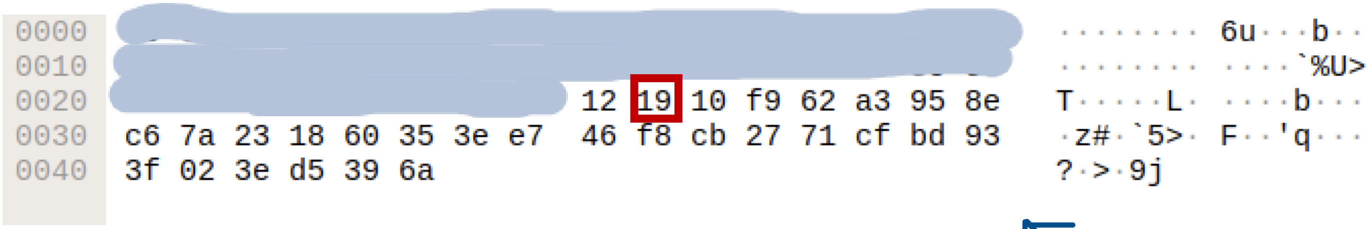
</table>

Apple BLE Frame Format



```
0000  [redacted]                                    ········ 6u···b··
0010                                                z·s····· ····`·U>
0020                          12 02 14 02 9c 12 57  T·····L· ······W
```

Nearby



```
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0010                                                    ········ ····`%U>
0020                          12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                 ?·>·9j
```

Separated

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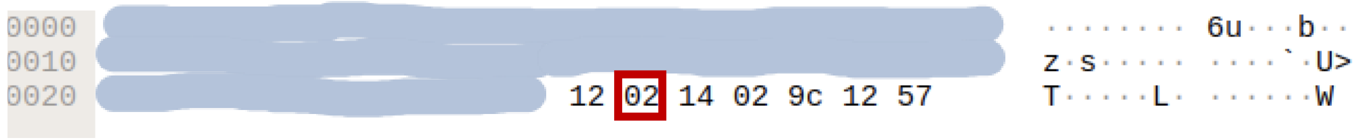
Continuity Protocol Explained

It's not a bug, it's a feature!

0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

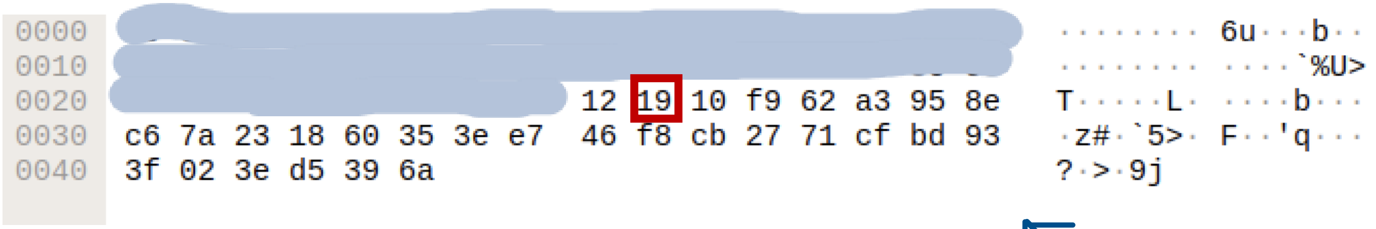
Apple BLE Frame Format



```
0000  [redacted]                                ········ 6u···b··
0010  [redacted]                                z·s····· ····`·U>
0020  [redacted]          12 02 14 02 9c 12 57  T·····L· ······W
```

Length = 2

Nearby



```
0000  [redacted]                                         ········ 6u···b··
0010  [redacted]                                         ········ ····`%U>
0020  [redacted]                 12 19 10 f9 62 a3 95 8e T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93    ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated

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Continuity Protocol Explained

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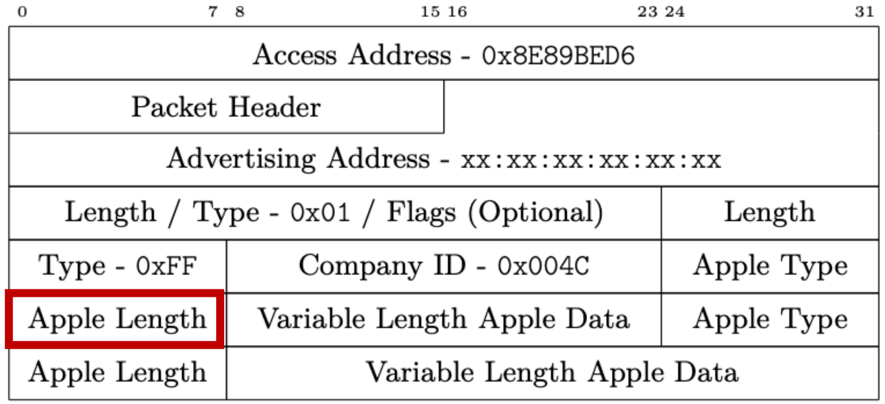

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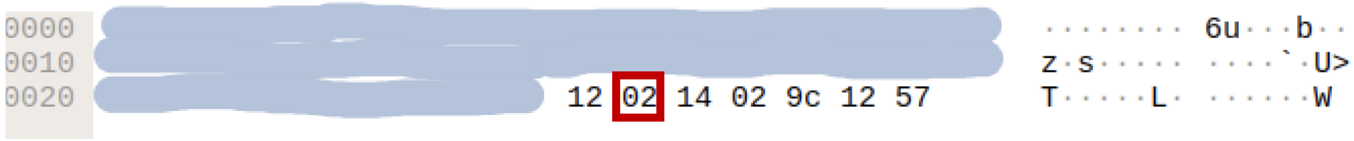
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td></tr>
</table>

Apple BLE Frame Format

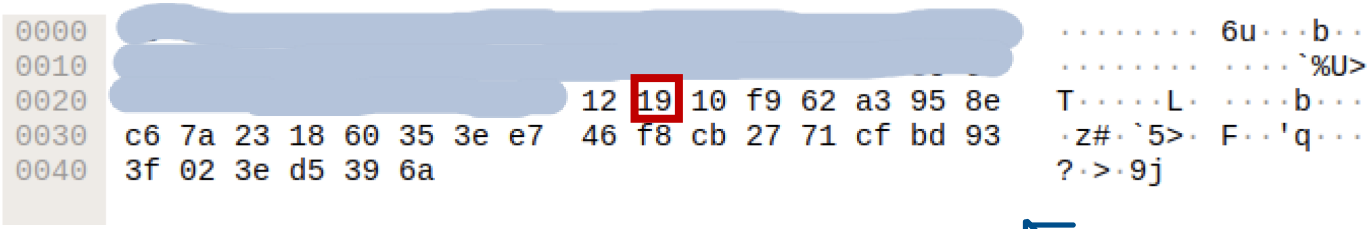


```
0000 [redacted]                              ········  6u···b··
0010                                         z·s·····  ····`·U>
0020                  12 02 14 02 9c 12 57   T·····L·  ······W
```

Length = 2

2 bytes

Nearby



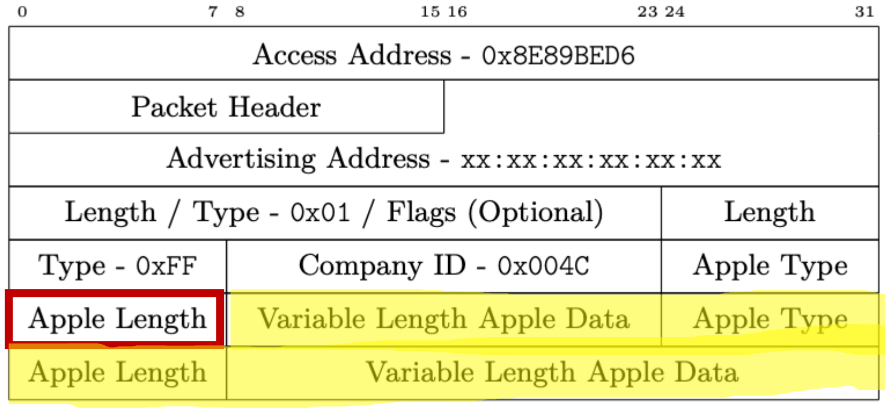
```
0000 [redacted]                                 ········  6u···b··
0010                                            ········  ····`%U>
0020                     12 19 10 f9 62 a3 95 8e  T·····L·  ····b···
0030 c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93  ·z#·`5>·  F··'q···
0040 3f 02 3e d5 39 6a                           ?·>·9j
```

Separated

PAUSE: WHY ARE THESE DIFFERENT?!

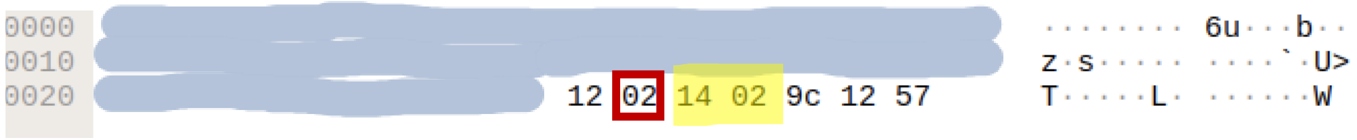
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

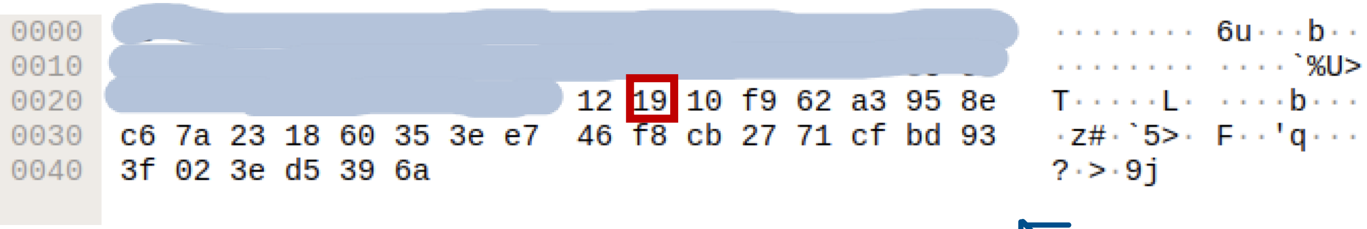


```
0000 [redacted]                                          ·········  6u···b··
0010                                                     z·s······  ····`·U>
0020                          12 02 14 02 9c 12 57       T·····L·   ······W
```

Length = 2

2 bytes

Nearby



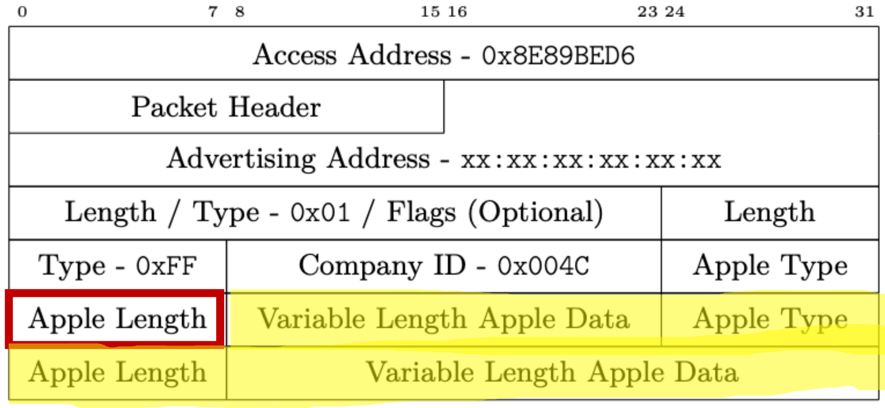
```
0000 [redacted]                                          ·········  6u···b··
0010                                                     ·········  ····`%U>
0020                          12 19 10 f9 62 a3 95 8e    T·····L·   ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93    ·z#·`5>·  F··'q···
0040 3f 02 3e d5 39 6a                                   ?·>·9j
```

Separated

PAUSE: WHY ARE THESE DIFFERENT?!

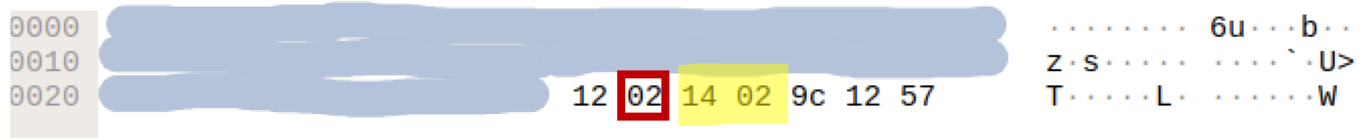
Continuity Protocol Explained

It's not a bug, it's a feature!



0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

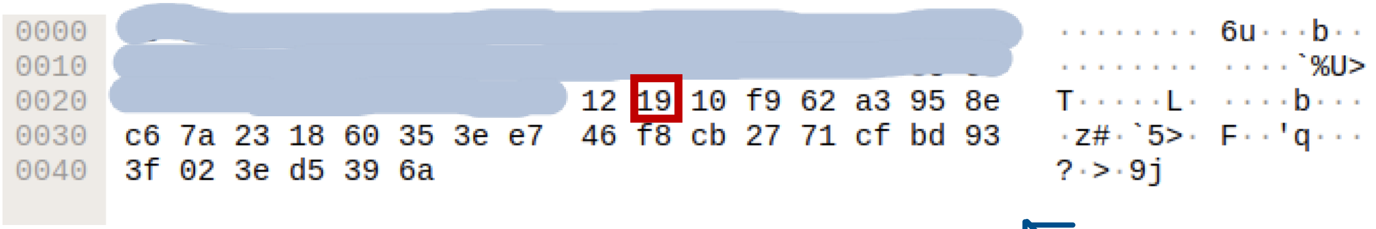


```
0000 [redacted]                                 · · · · · · · ·  6u· · ·b· ·
0010 [redacted]                                 z·s· · · · ·   · · · ·`·U>
0020 [redacted]          12 02 14 02 9c 12 57    T· · · · ·L·   · · · · · ·W
```

Length = 2

2 bytes

Nearby



```
0000 [redacted]                                 · · · · · · · ·  6u· · ·b· ·
0010 [redacted]                                 · · · · · · · ·  · · · ·`%U>
0020 [redacted]          12 19 10 f9 62 a3 95 8e   T· · · · ·L·  · · · ·b· · ·
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·  F· ·'q· · ·
0040 3f 02 3e d5 39 6a                                  ?·>·9j
```

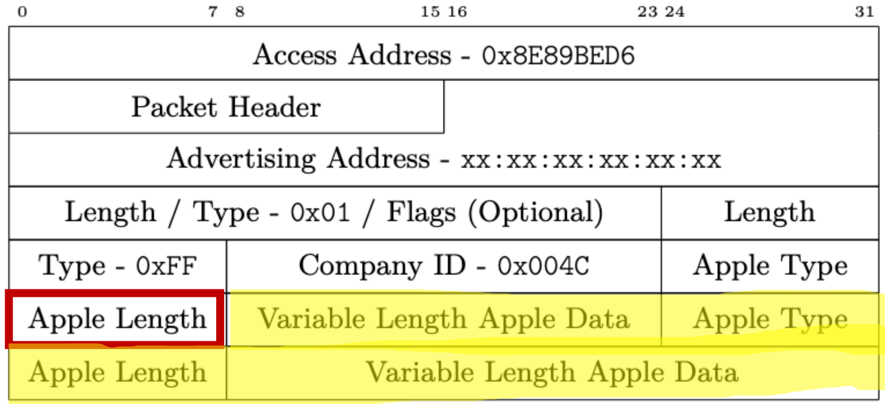
Length = 25

Separated

PAUSE: WHY ARE THESE DIFFERENT?!

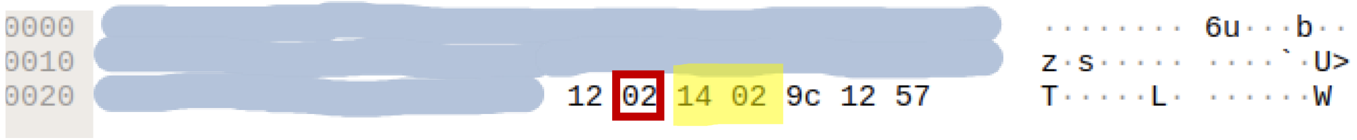
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

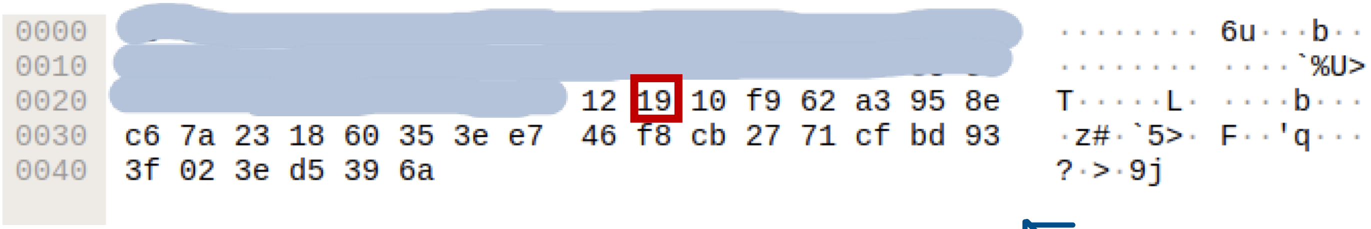


```
0000  [redacted]                                       ········  6u···b··
0010                                                   z·s·····  ····`·U>
0020                           12 02 14 02 9c 12 57    T·····L·  ······W
```

Length = 2

2 bytes

Nearby



```
0000  [redacted]                                       ········  6u···b··
0010                                                   ········  ····`%U>
0020                           12 19 10 f9 62 a3 95 8e  T·····L·  ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>·  F··'q···
0040  3f 02 3e d5 39 6a                                 ?·>·9j
```

Length = 25

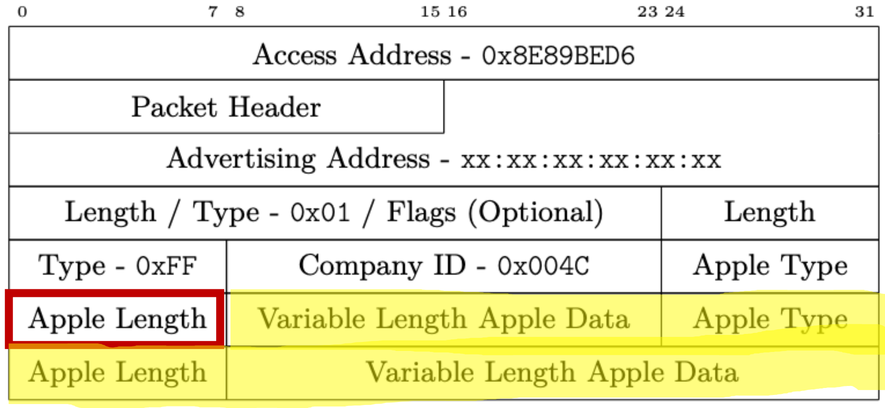
25 bytes

Separated

PAUSE: WHY ARE THESE DIFFERENT?!

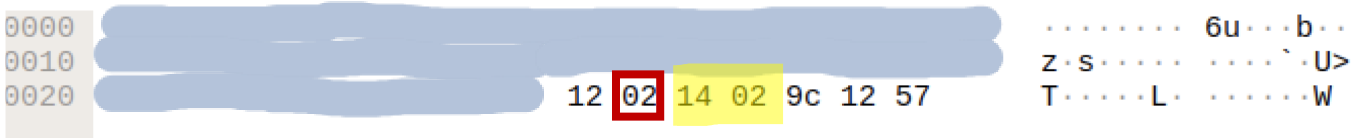
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

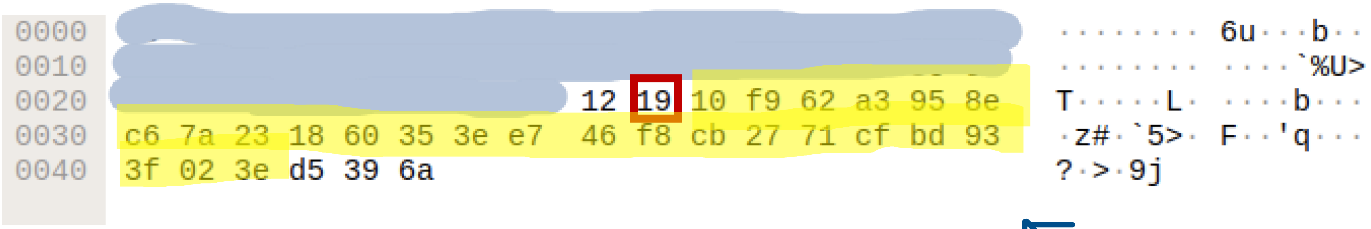


```
0000  [redacted]                                          ········ 6u··b··
0010                                                      z·s····· ····`·U>
0020                              12 02 14 02 9c 12 57    T·····L· ······W
```

Length = 2

2 bytes

Nearby



```
0000  [redacted]                                          ········ 6u··b··
0010                                                      ········ ····`%U>
0020                              12 19 10 f9 62 a3 95 8e T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93    ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                   ?·>·9j
```

Length = 25

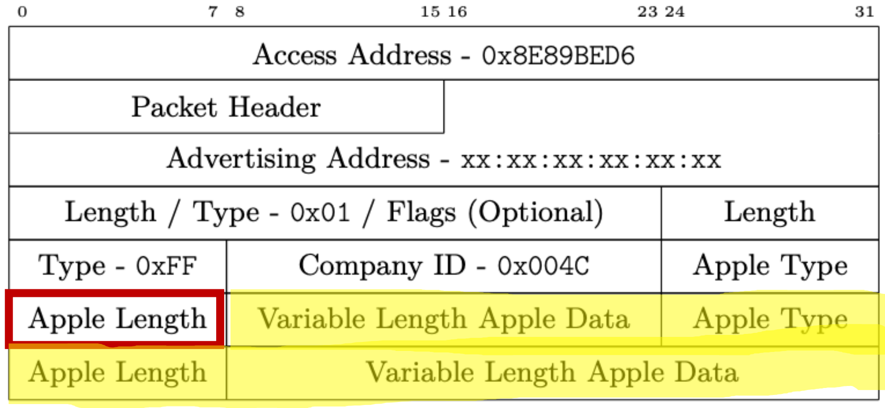
25 bytes

Separated

PAUSE: WHY ARE THESE DIFFERENT?!

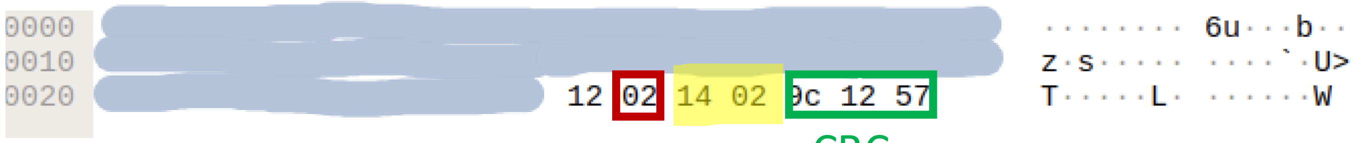
Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



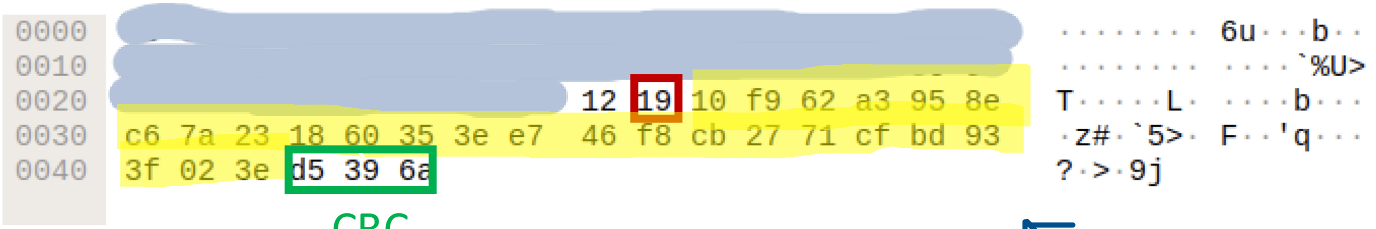
```
0000 [redacted]                                   ·········  6u···b··
0010                                              z·s······  ·····`·U>
0020                      12 02 14 02 9c 12 57    T·····L·  ·······W
```

CRC

Length = 2

2 bytes

Nearby



```
0000 [redacted]                                   ·········  6u···b··
0010                                              ·········  ·····`%U>
0020                      12 19 10 f9 62 a3 95 8e T·····L·  ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93 ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                            ?·>·9j
```

CRC

Length = 25

25 bytes

Separated

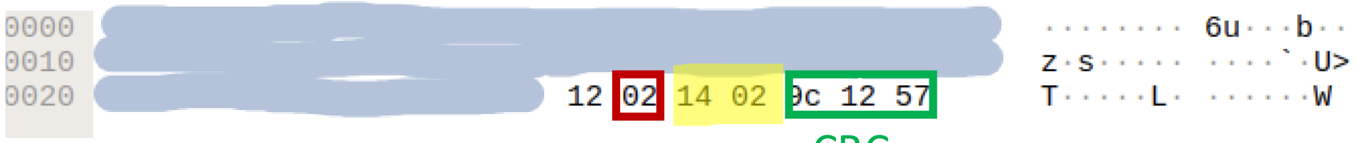
PAUSE: WHY ARE THESE DIFFERENT?!

Continuity Protocol Explained

It’s not a bug, it’s a feature!

0 … 7	8 … 15	16 … 23	24 … 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                  ........  6u...b..
0010  [redacted]                                  z.s.....  ....`.U>
0020  [redacted]          12 02 14 02 0c 12 57    T.....L.  ......W
```

CRC

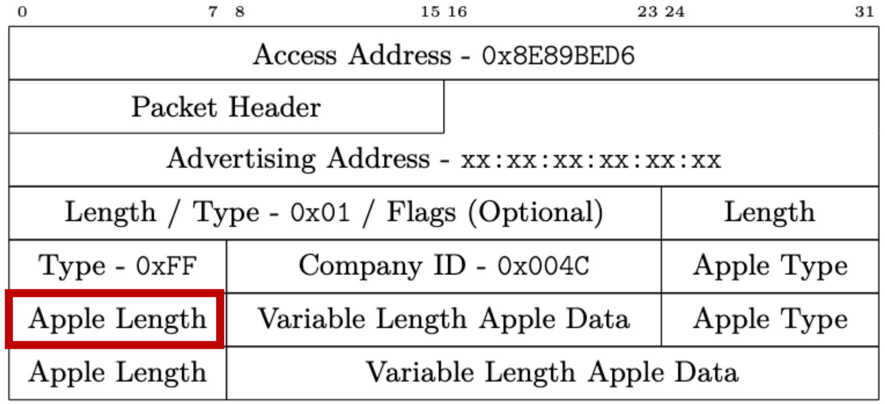
Length = 2

2 bytes

Nearby

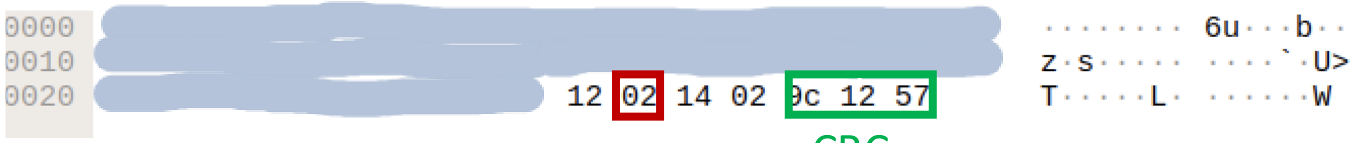
Continuity Protocol Explained

It's not a bug, it's a feature!



0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                    ·········  6u···b··
0010 [redacted]                                    z·s·····  ····`·U>
0020 [redacted]            12 02 14 02 0c 12 57    T·····L·  ······W
```

CRC

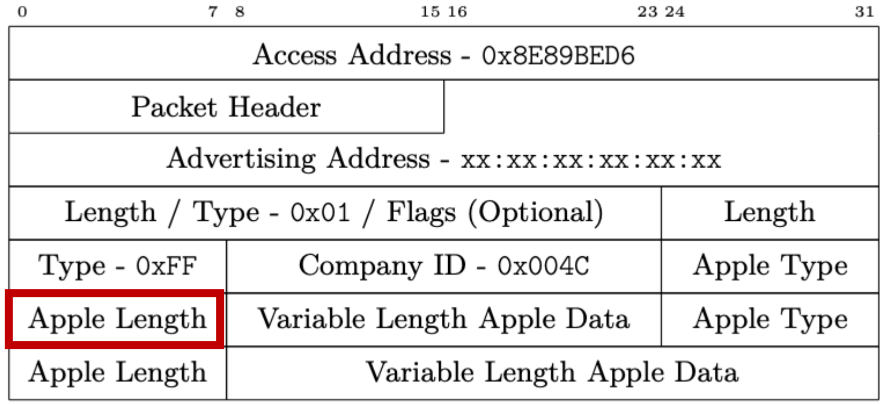
Length = 2

2 bytes

Nearby

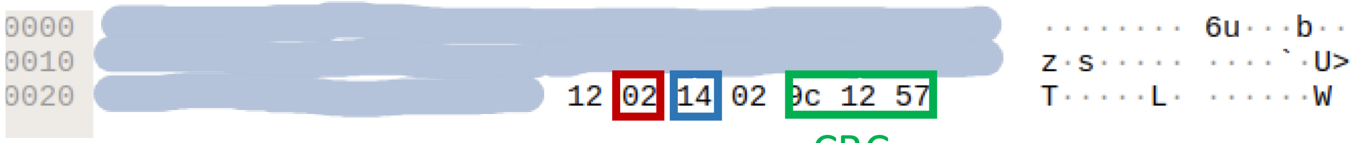
Continuity Protocol Explained

It's not a bug, it's a feature!



0 - 7	8 - 15	16 - 23	24 - 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                 ·········  6u···b··
0010                                             z·s······  ····`·U>
0020                     12 02 14 02 9c 12 57    T·····L·   ······W
```

CRC

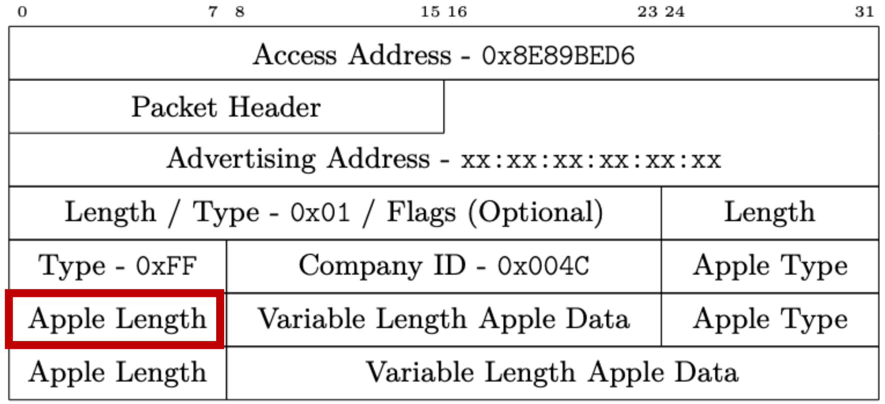
Length = 2

2 bytes

Nearby

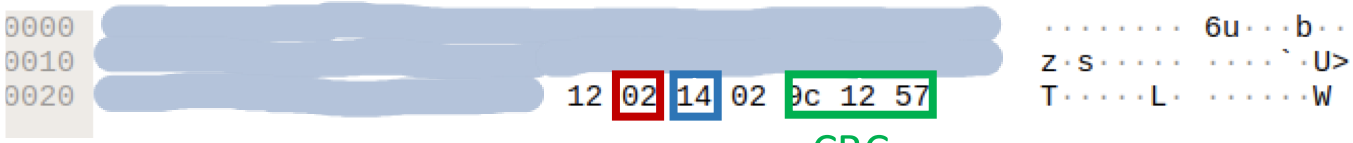
Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                      · · · · · · · ·  6u · · · b · ·
0010 [redacted]                      z · s · · · · ·  · · · · ` · U>
0020 [redacted]  12 02 14 02 0c 12 57  T · · · · · L ·  · · · · · · W
```

CRC

Length = 2

2 bytes

Nearby

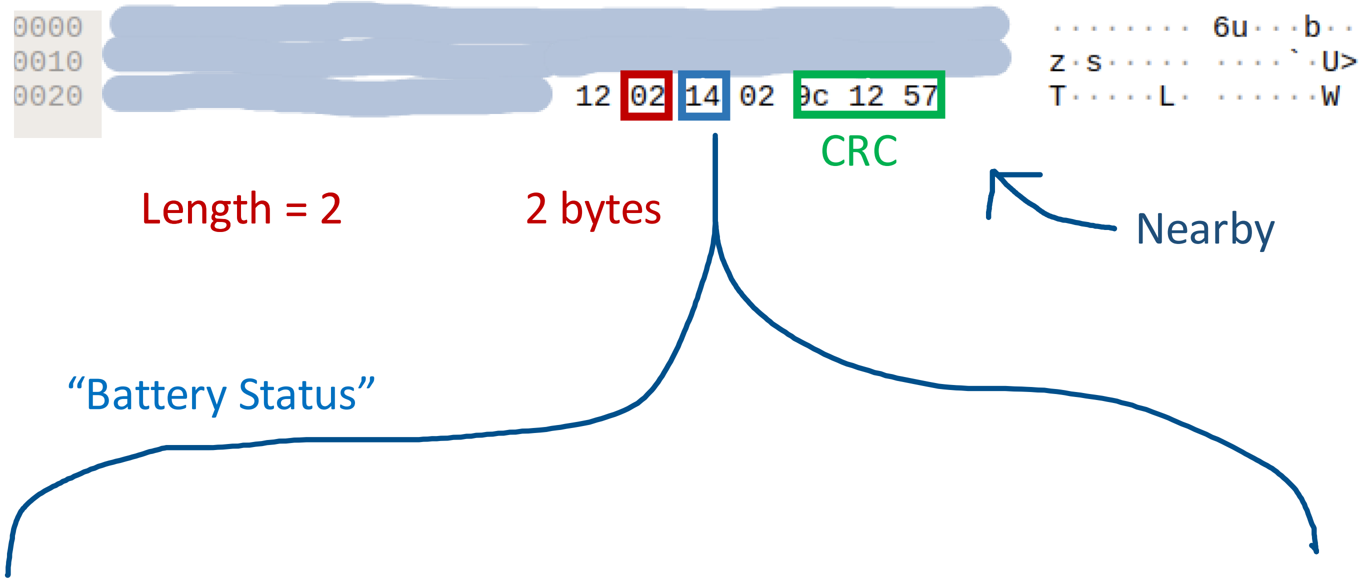
“Battery Status”

Continuity Protocol Explained

It’s not a bug, it’s a feature!

0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

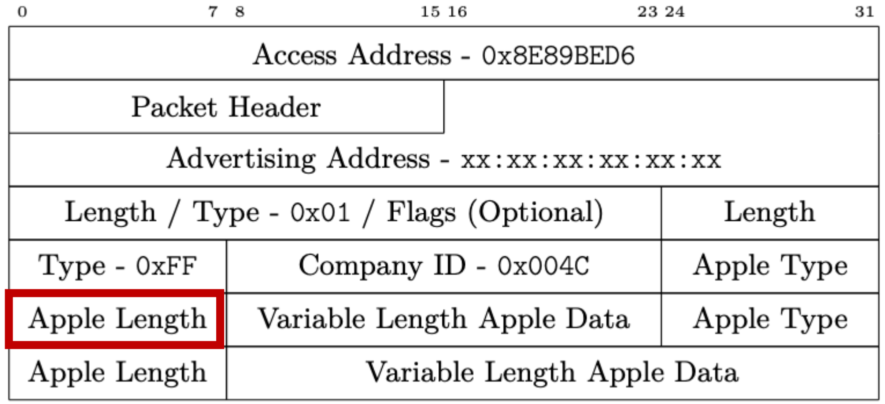
Apple BLE Frame Format



```
0000 [redacted]                          ........ 6u···b··
0010 [redacted]                          z·s····· ····`·U>
0020 [redacted]   12 02 14 02 9c 12 57   T·····L· ······W
```

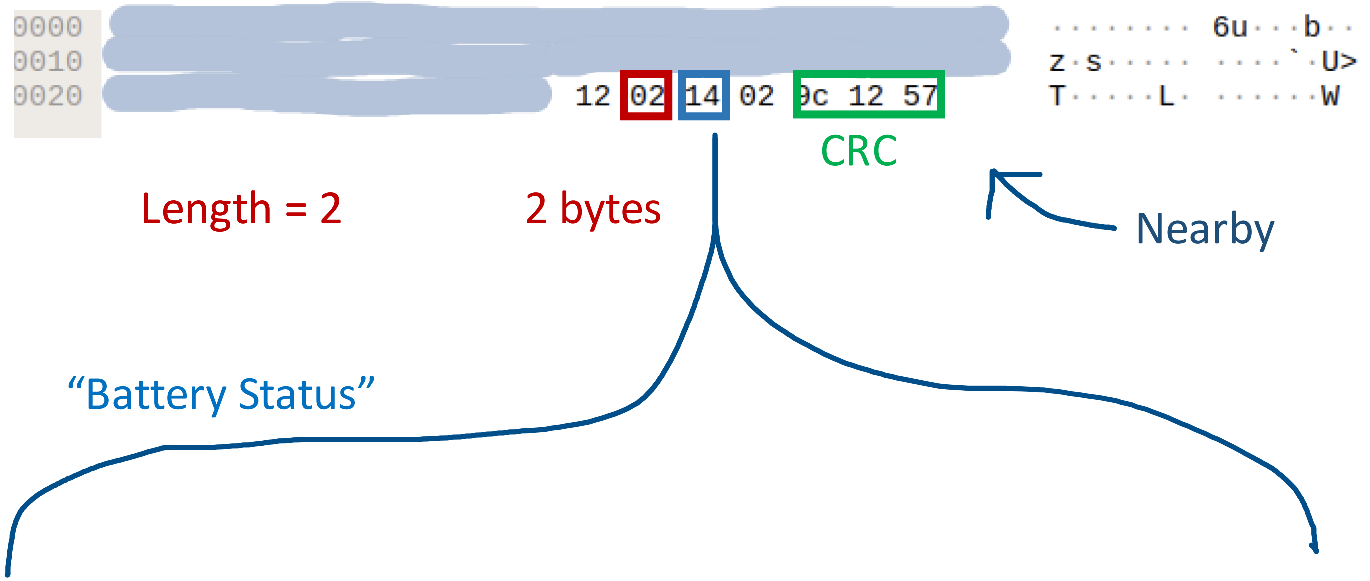
Continuity Protocol Explained

It’s not a bug, it’s a feature!



<table>
<tr><td>0</td><td>7 8</td><td>15 16</td><td>23 24</td><td>31</td></tr>
<tr><td colspan="5">Access Address - 0x8E89BED6</td></tr>
<tr><td colspan="3">Packet Header</td><td colspan="2"></td></tr>
<tr><td colspan="5">Advertising Address - xx:xx:xx:xx:xx:xx</td></tr>
<tr><td colspan="4">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="3">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="4">Variable Length Apple Data</td></tr>
</table>

Apple BLE Frame Format

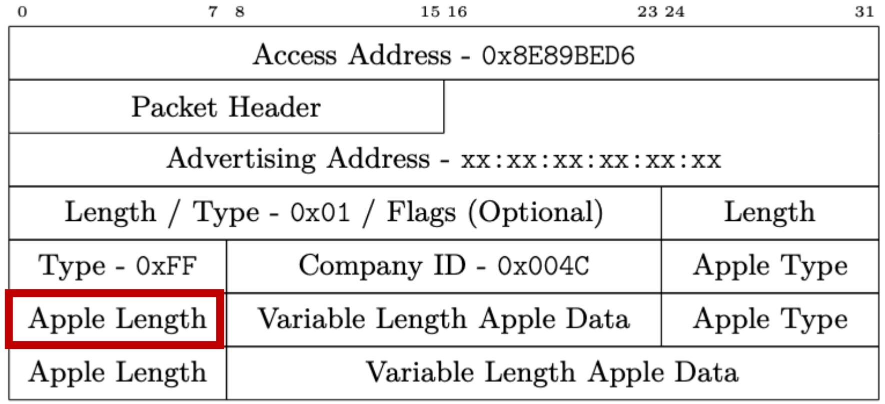


```
0000 [redacted]                          · · · · · · · · ·   6u· · ·b· ·
0010                                     z·s· · · · ·   · · · ·`·U>
0020                12 02 14 02 0c 12 57  T· · · · ·L·   · · · · · ·W
```

7	6	5	4	3	2	1	0

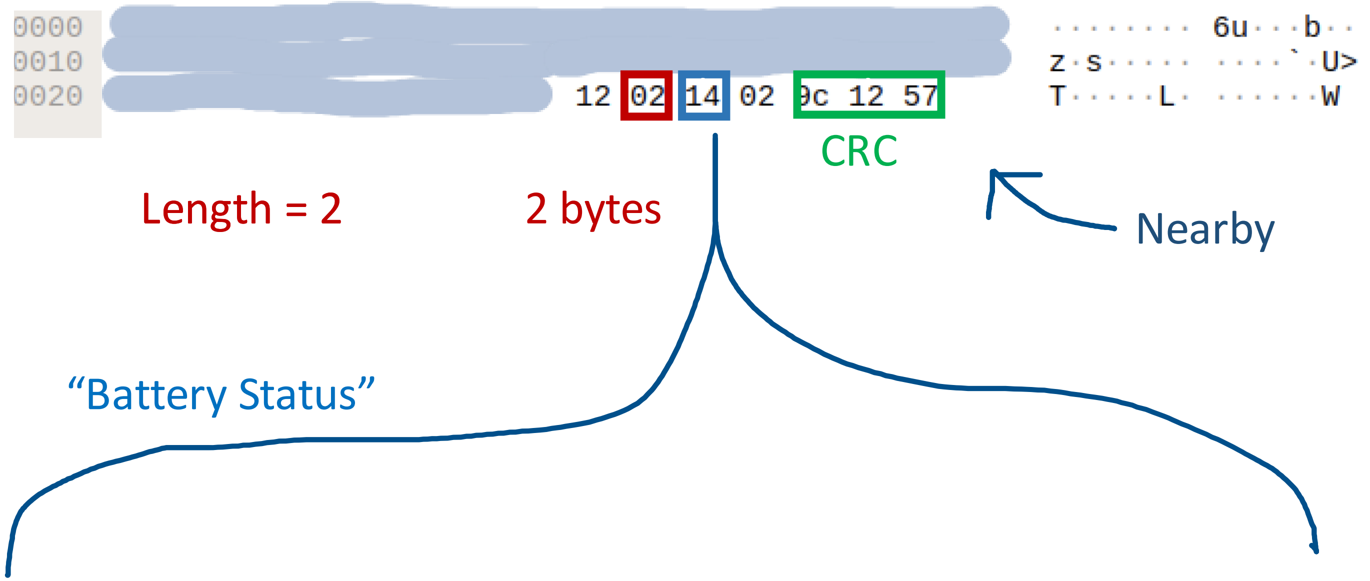
Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

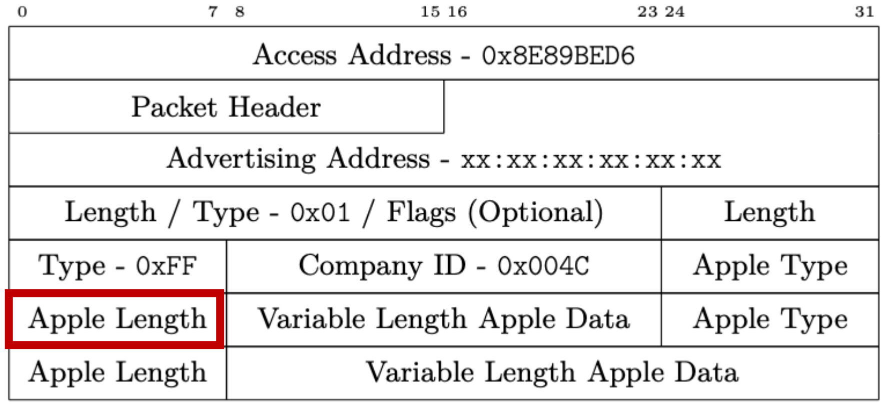


```
0000 [redacted]                          ········ 6u···b··
0010                                     z·s····· ····`·U>
0020                     12 02 14 02 9c 12 57    T·····L· ······W
```

7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0

Continuity Protocol Explained

It’s not a bug, it’s a feature!

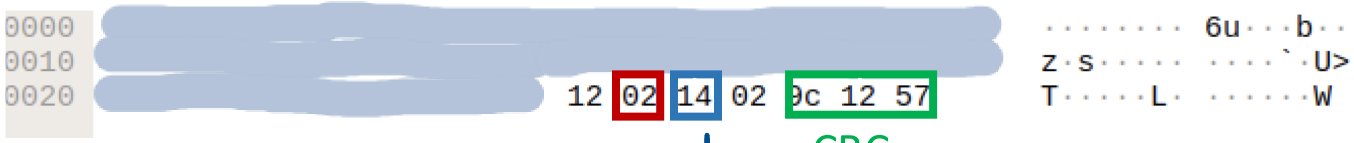


0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

4.5.3.4.13. Battery status

Description
0 = Full 1 = Medium 2 = Low 3 = Critically low



```
0000 [redacted]                             ........ 6u...b..
0010                                        z.s..... ....`.U>
0020                    12 02 14 02 9c 12 57   T.....L. ......W
```

CRC

Length = 2

2 bytes

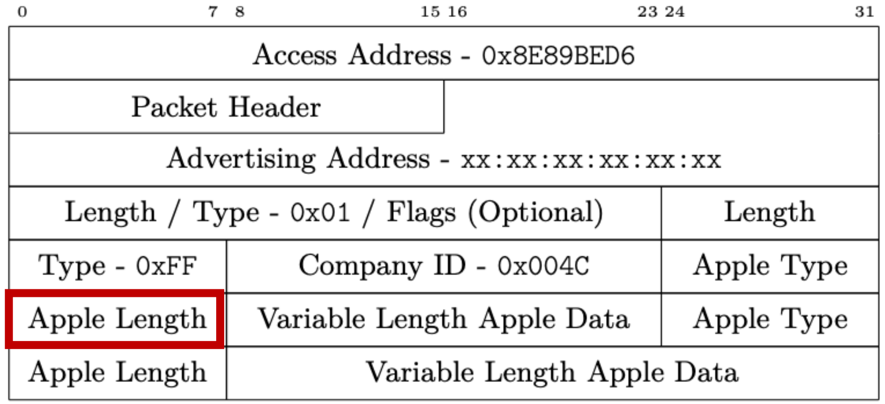
Nearby

“Battery Status”

7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0
Battery	Battery	Reserved	Tracking	Reserved	Maintained	Reserved	Reserved

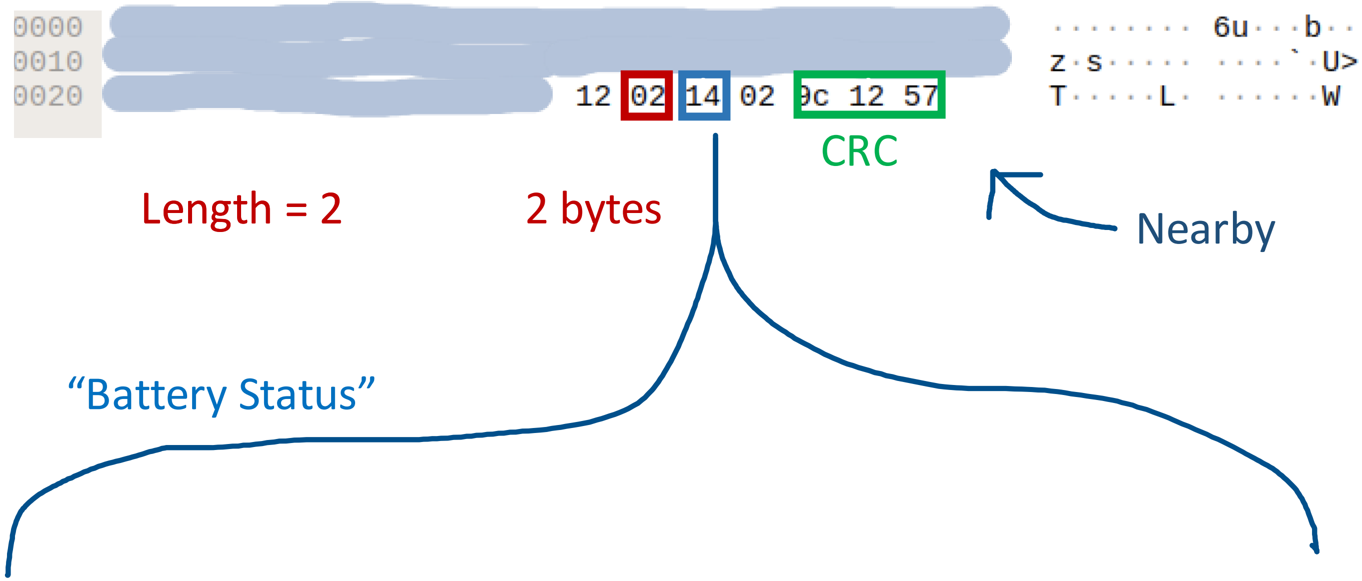
Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

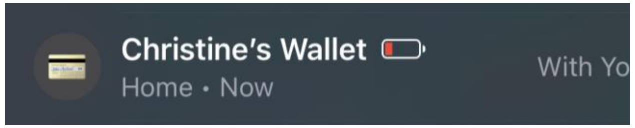


```
0000 [redacted]                          ·········  6u···b··
0010 [redacted]                          z·s·····  ····`·U>
0020 [redacted]     12 02 14 02 0c 12 57  T·····L·  ······W
```

7	6	5	4	3	2	1	0
0	0	0	1	0	1	0	0
Battery	Battery	Reserved	Tracking	Reserved	Maintained	Reserved	Reserved

4.5.3.4.13. Battery status

Description
0 = Full
1 = Medium
2 = Low
3 = Critically low

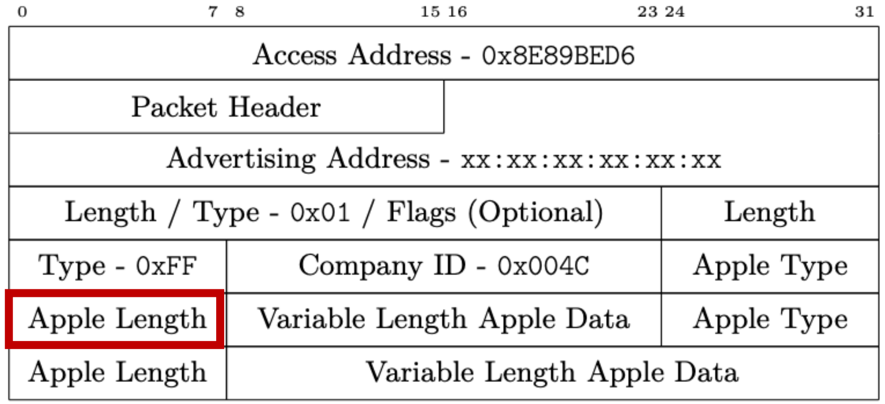


Christine’s Wallet
Home • Now

With Yo

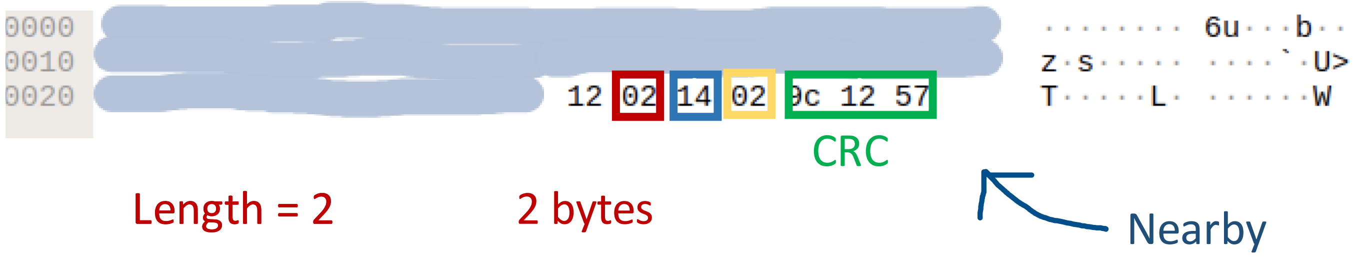
Continuity Protocol Explained

It's not a bug, it's a feature!



0 … 7	8 … 15	16 … 23	24 … 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                             ........ 6u...b..
0010                                        z.s..... ....`.U>
0020                 12 02 14 02 0c 12 57   T.....L. ......W
```

CRC

Length = 2

2 bytes

Nearby

Continuity Protocol Explained

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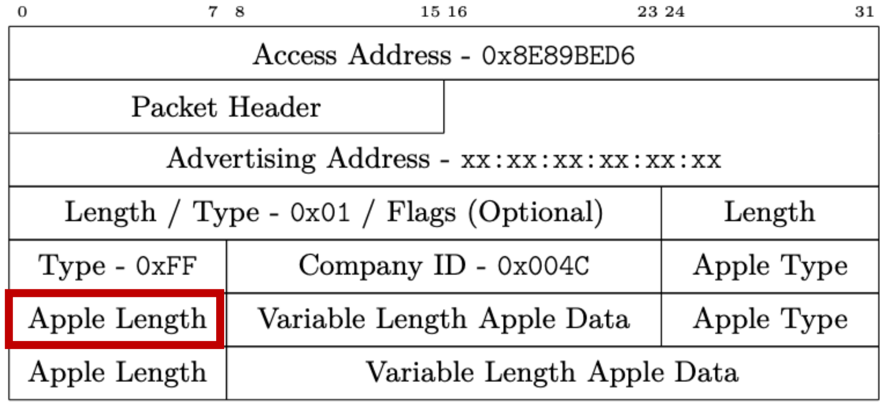

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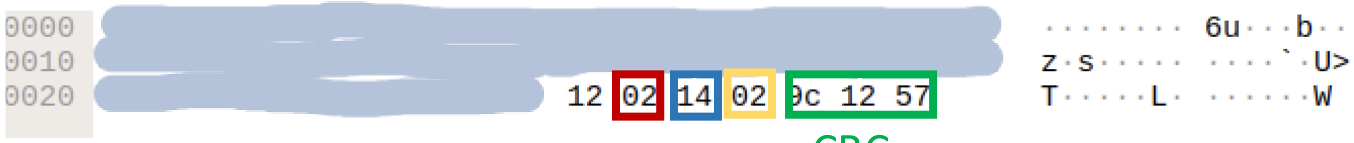
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                 · · · · · · · ·  6u · · · b · ·
0010                                            z · s · · · · ·  · · · · ` · U>
0020                      12 02 14 02 0c 12 57  T · · · · · L ·  · · · · · · W
```

CRC

Length = 2

2 bytes

Nearby

Public Key Bits

Continuity Protocol Explained

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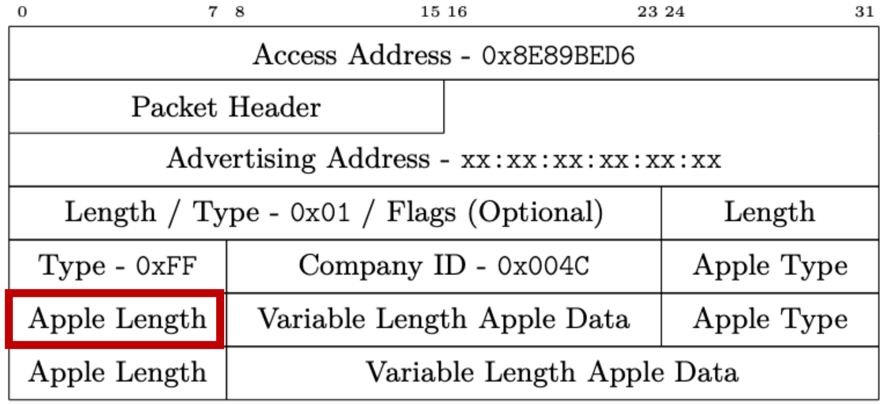

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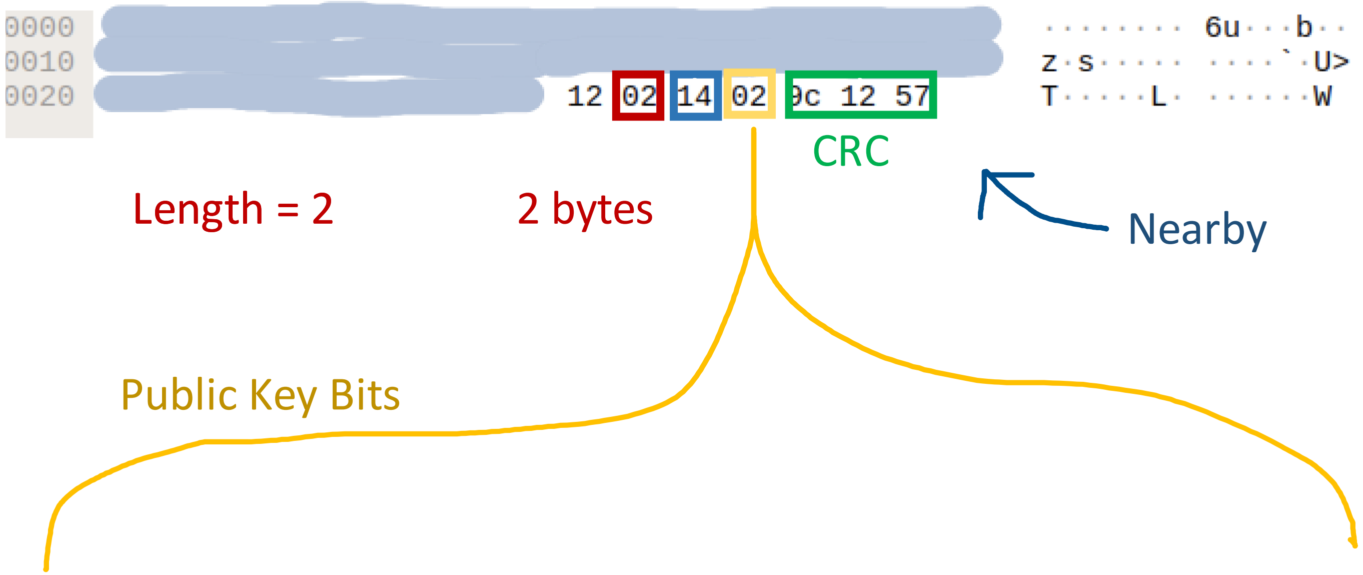
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                 ·········  6u···b··
0010                                            z·s·····  ····`·U>
0020                      12 02 14 02 9c 12 57  T·····L·  ······W
```

CRC

Length = 2

2 bytes

Nearby

Public Key Bits

Continuity Protocol Explained

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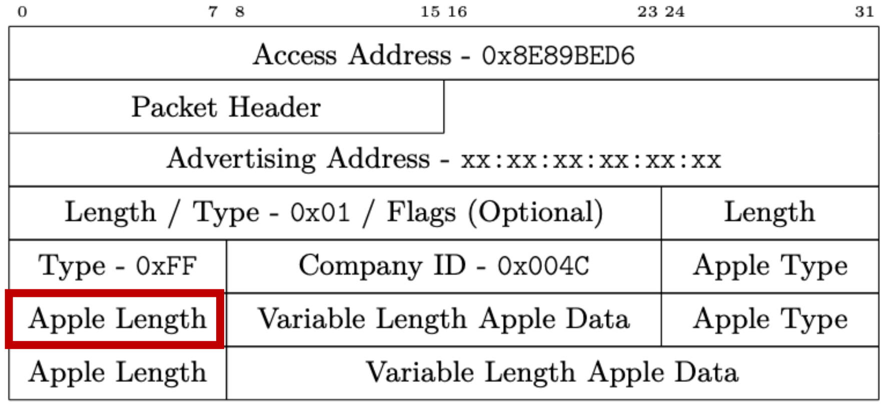
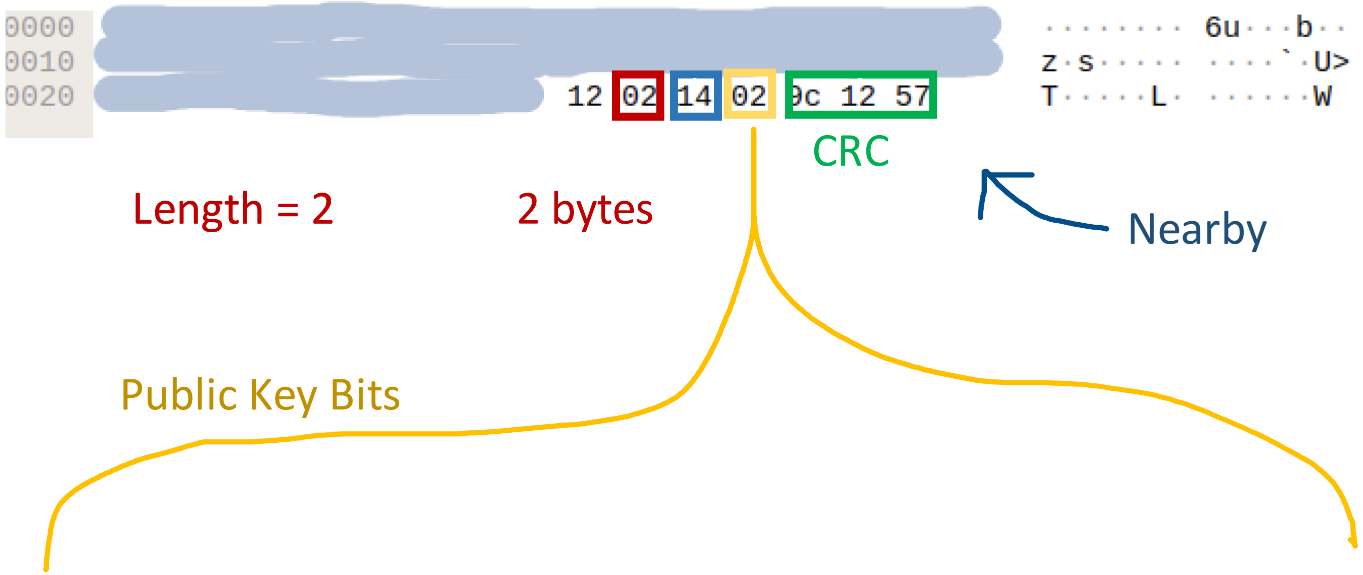


0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                ........ 6u...b..
0010                                           z.s..... ....`.U>
0020                     12 02 14 02 9c 12 57  T.....L. ......W
```

7	6	5	4	3	2	1	0

Continuity Protocol Explained

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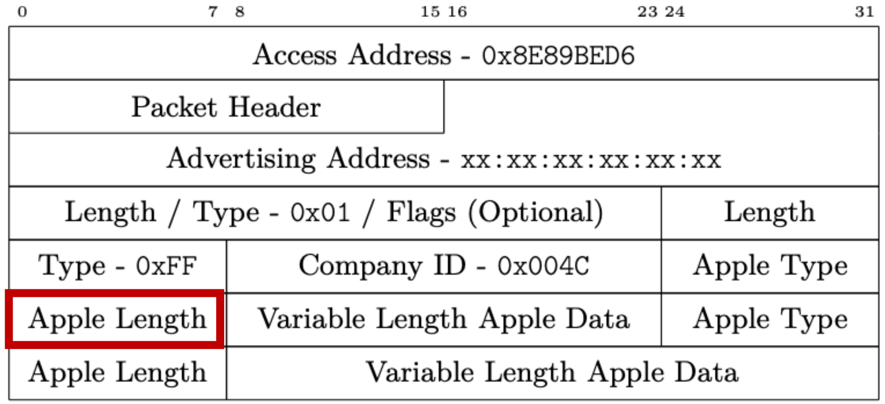

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<tr><td colspan="3">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
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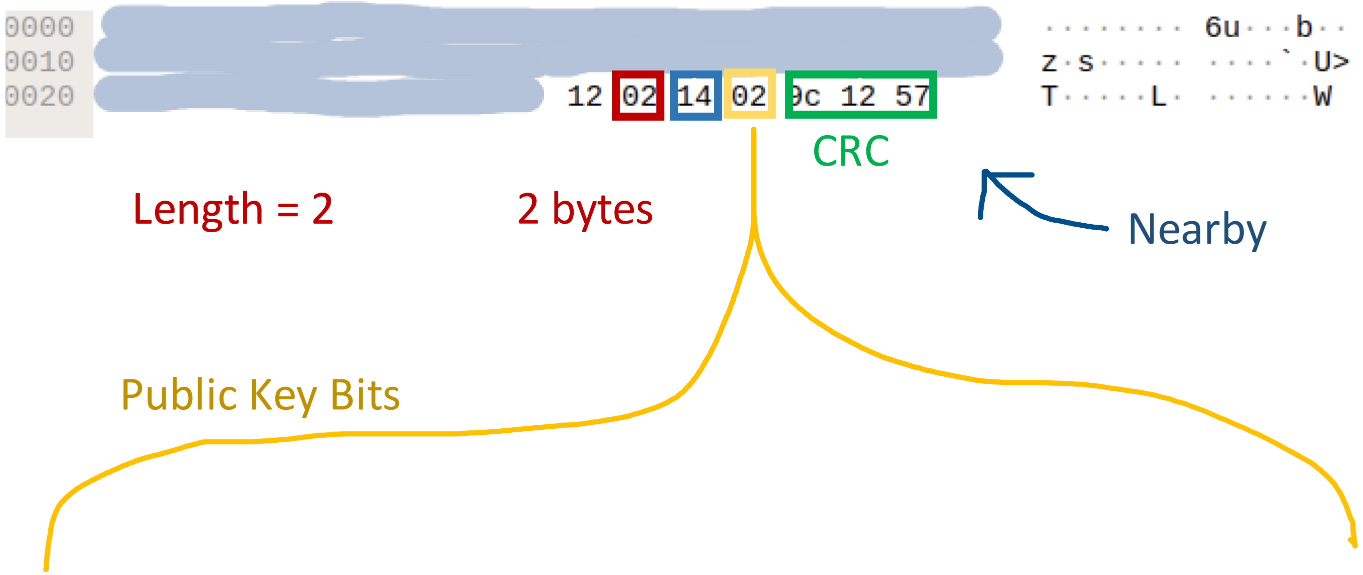
Apple BLE Frame Format



```
0000 [redacted]                                  ········ 6u···b··
0010 [redacted]                                  z·s····· ····`·U>
0020 [redacted]            12 02 14 02 9c 12 57  T·····L· ·······W
```

7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0

Continuity Protocol Explained

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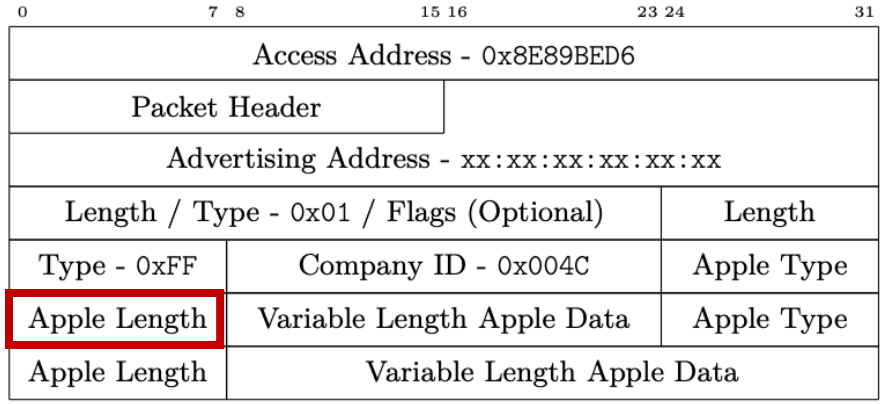


Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

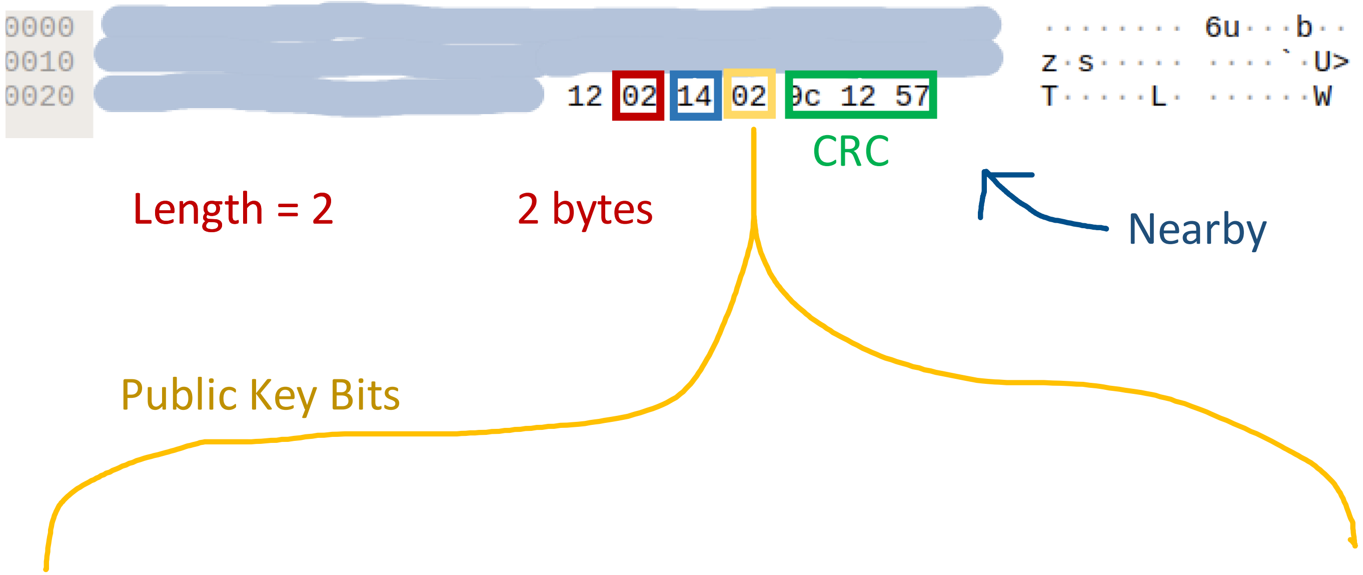
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

Apple BLE Frame Format

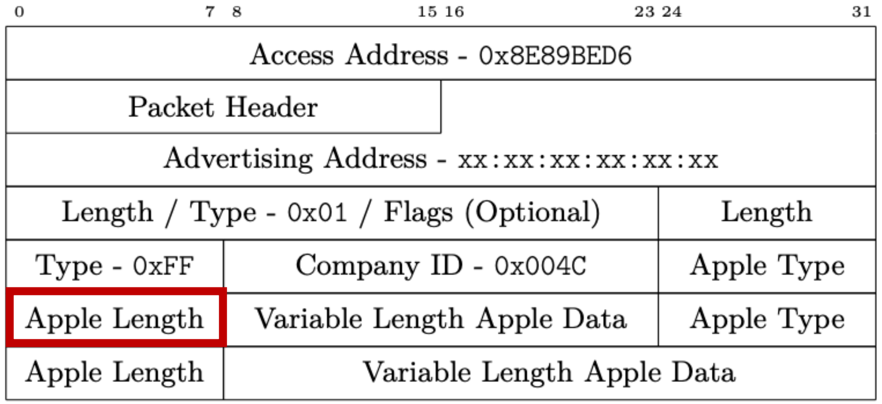


```
0000 [redacted]                                  · · · · · · · · ·   6u · · · b · ·
0010                                             z · s · · · · ·   · · · · ` · U>
0020                       12 02 14 02 0c 12 57  T · · · · · L ·   · · · · · · W
```

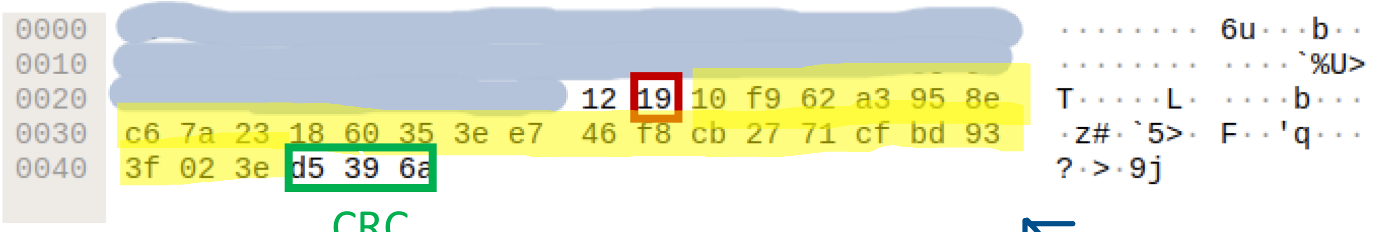
7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Pub Key	Pub Key

Continuity Protocol Explained

It's not a bug, it's a feature!



Access Address - 0x8E89BED6		
Packet Header		
Advertising Address - xx:xx:xx:xx:xx:xx		
Length / Type - 0x01 / Flags (Optional)		Length
Type - 0xFF	Company ID - 0x004C	Apple Type
Apple Length	Variable Length Apple Data	Apple Type
Apple Length	Variable Length Apple Data	



```
0000  [redacted]                                       ........ 6u..b..
0010  [redacted]                                       ........ ....`%U>
0020  [redacted]                12 19 10 f9 62 a3 95 8e  T.....L. ....b...
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  .z#.`5>. F..'q...
0040  3f 02 3e d5 39 6a                                 ?.>.9j
```

CRC

Length = 25

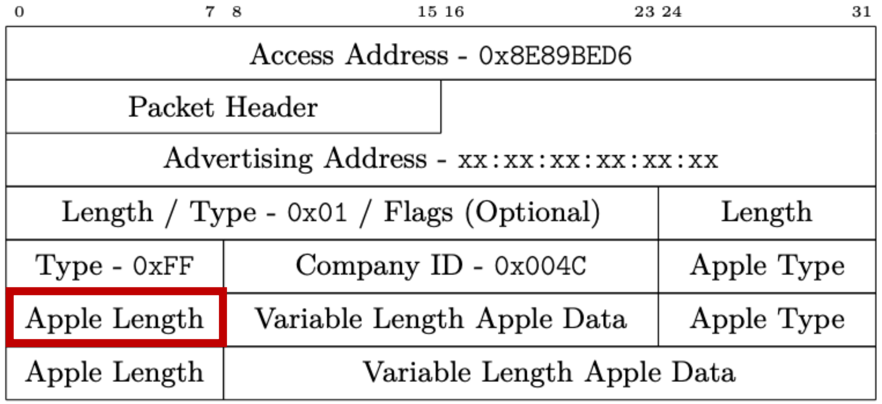
25 bytes

Separated

Apple BLE Frame Format

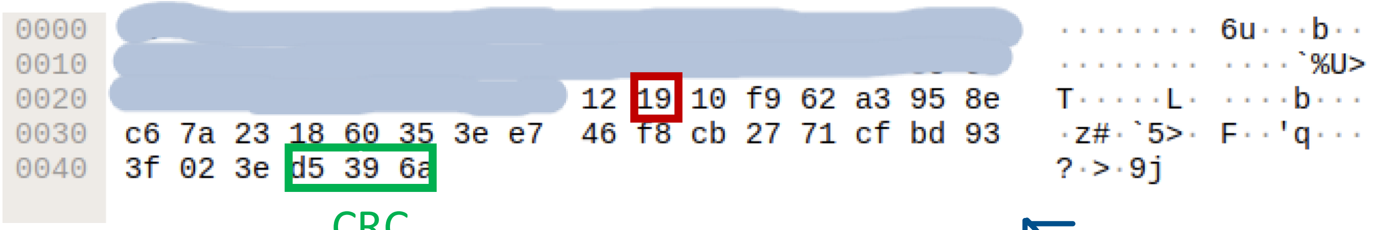
Continuity Protocol Explained

It’s not a bug, it’s a feature!



Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                          ········ 6u···b··
0010                                                     ········ ····`%U>
0020                             12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                                  ?·>·9j
```

CRC

Length = 25

Separated

Continuity Protocol Explained

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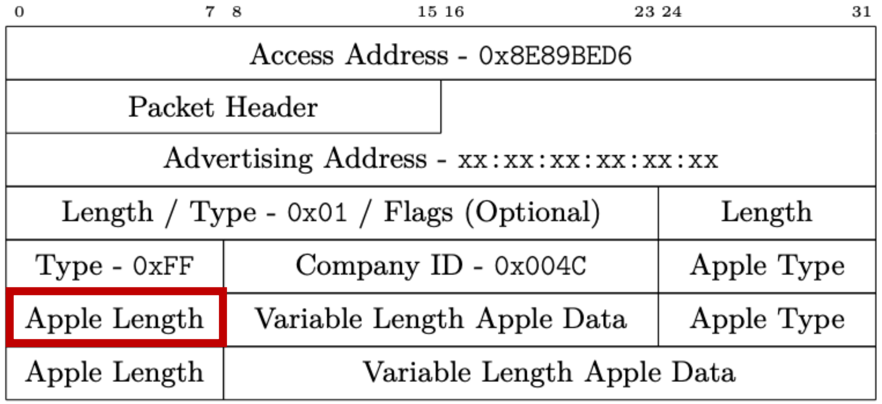

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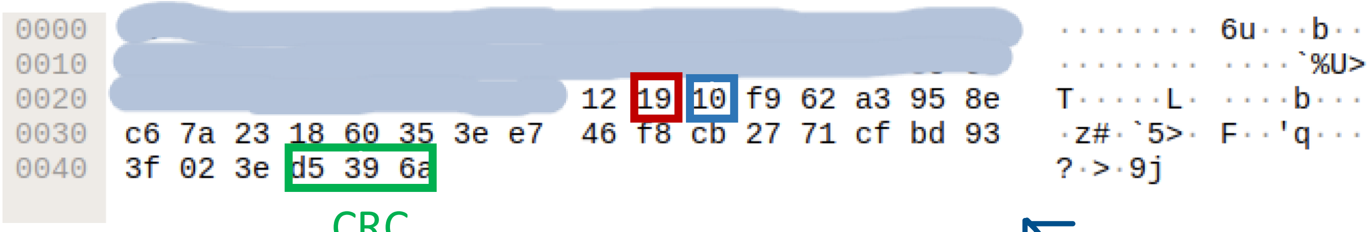
<tr><td colspan="3">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td></tr>
</table>

Apple BLE Frame Format



```
0000  [redacted]                                         ········ 6u···b··
0010                                                     ········ ····`%U>
0020                           12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

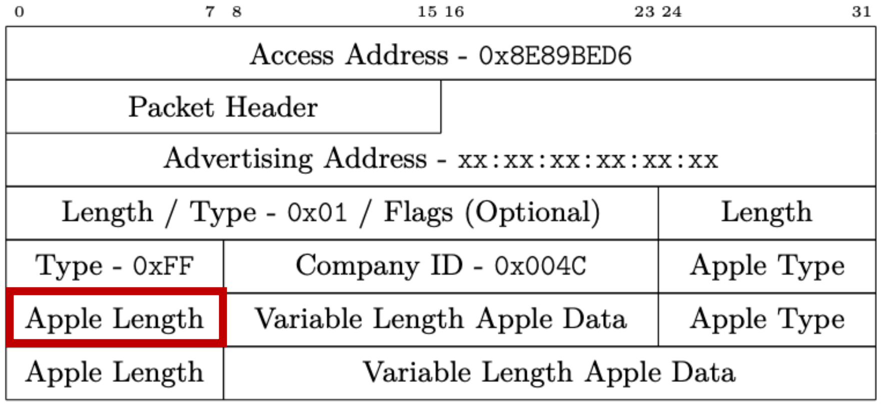
CRC

Length = 25

Separated

Continuity Protocol Explained

It's not a bug, it's a feature!



0 7 8 15 16 23 24 31

Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

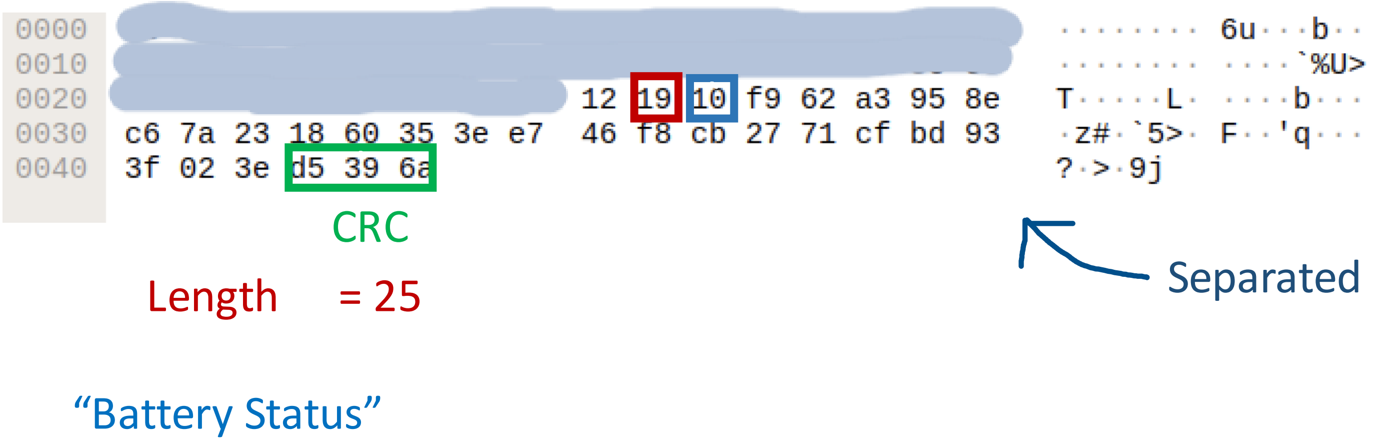
Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

Apple BLE Frame Format



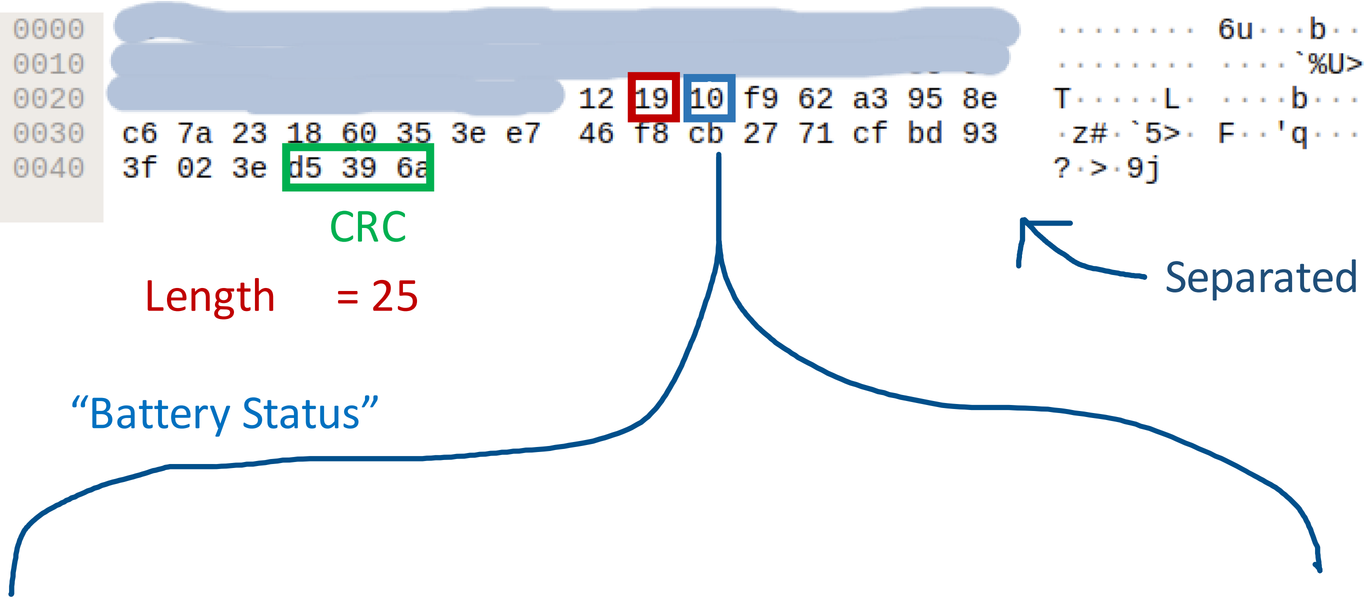
```
0000 [redacted]                                        ········ 6u··b··
0010                                                   ········ ····`%U>
0020                         12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030 c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                                 ?·>·9j
```

Continuity Protocol Explained

It's not a bug, it's a feature!

0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                          · · · · · · · ·  6u · · b · ·
0010                                                     · · · · · · · ·  · · · · `%U>
0020                          12 19 10 f9 62 a3 95 8e    T · · · · · L ·  · · · · b · · ·
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93    · z# · `5> ·  F · · 'q · · ·
0040 3f 02 3e d5 39 6a                                   ? · > · 9j
```

Continuity Protocol Explained

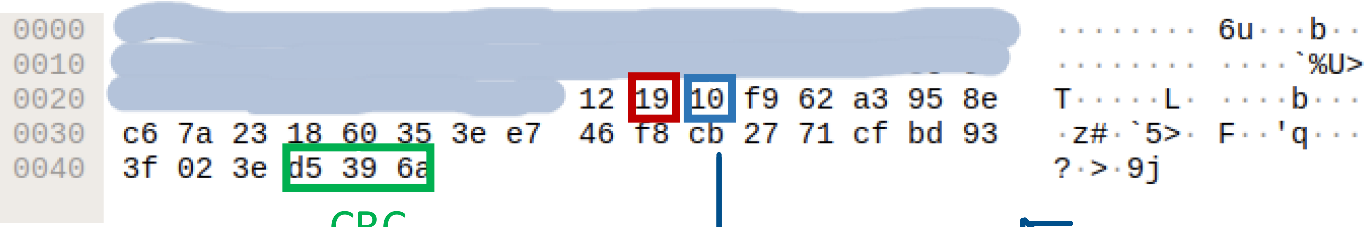
It’s not a bug, it’s a feature!

0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

4.5.3.4.13. Battery status

Description
0 = Full 1 = Medium 2 = Low 3 = Critically low



```
0000  [redacted]                                          ........ 6u···b··
0010                                                      ........ ····`%U>
0020                            12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7   46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                   ?·>·9j
```

CRC

Length = 25

Separated

“Battery Status”

7	6	5	4	3	2	1	0
0	0	0	1	0	0	0	0
Battery	Battery	Reserved	Tracking	Reserved	Maintained	Reserved	Reserved

Disconnected

Continuity Protocol Explained

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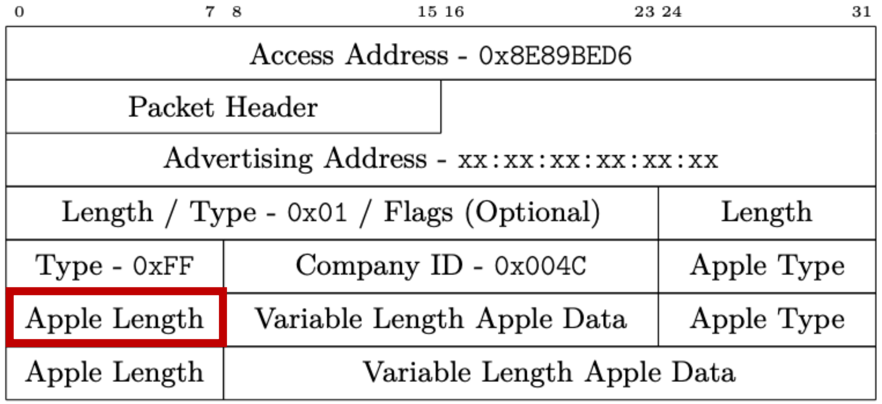
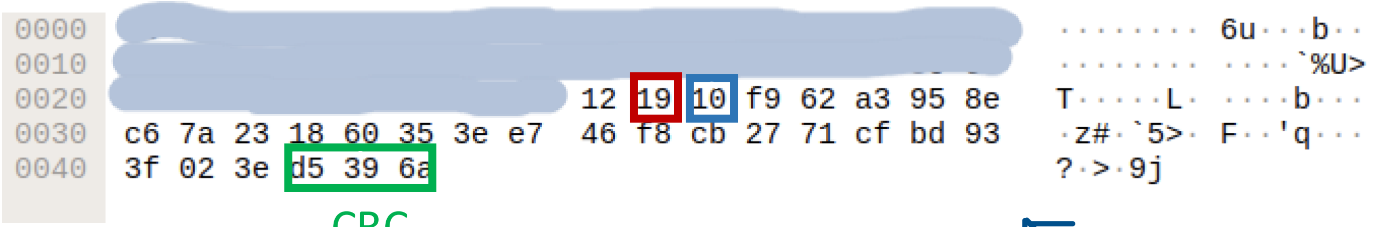


0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

Apple BLE Frame Format



```
0000  [redacted]                                         ········ 6u···b··
0010                                                     ········ ····`%U>
0020                            12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7   46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

CRC

Length = 25

Separated

Continuity Protocol Explained

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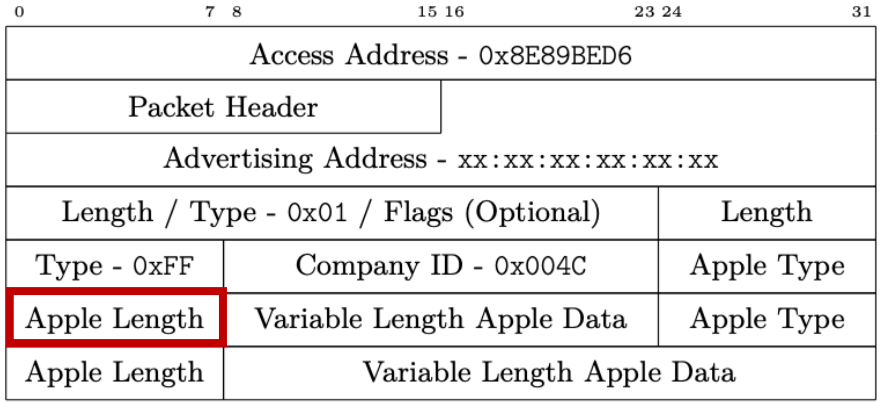
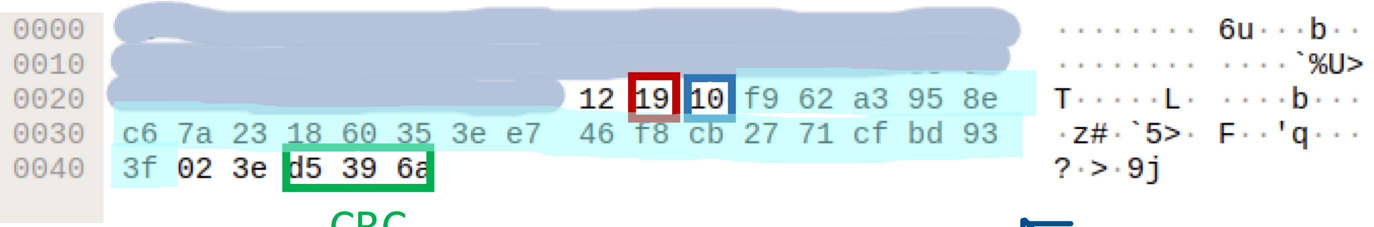


0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

Apple BLE Frame Format



```
0000 [redacted]                                       ········ 6u···b··
0010                                                  ········ ····`%U>
0020                           12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040 3f 02 3e d5 39 6a                                  ?·>·9j
```

CRC

Length = 25

Separated

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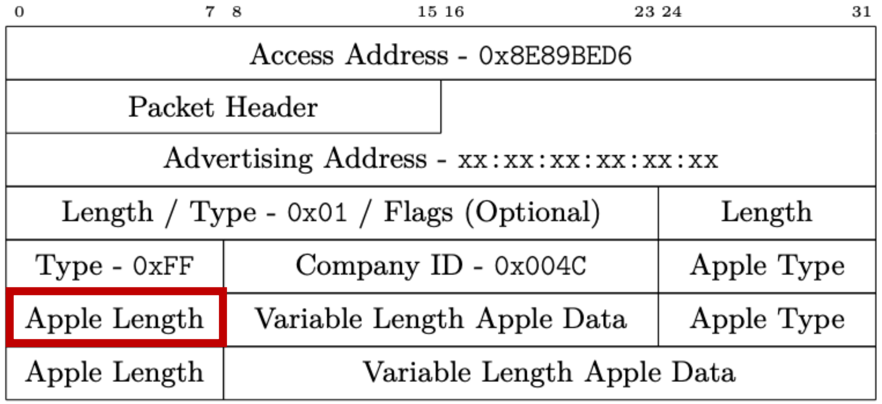

0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
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Apple Length	Variable Length Apple Data		Apple Type
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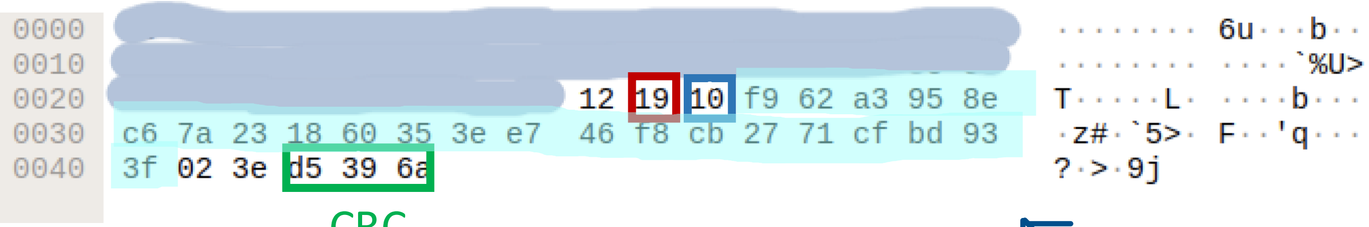
Apple BLE Frame Format



```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ········ ····`%U>
0020                          12 19 10 f9 62 a3 95 8e     T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93     ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                   ?·>·9j
```

CRC

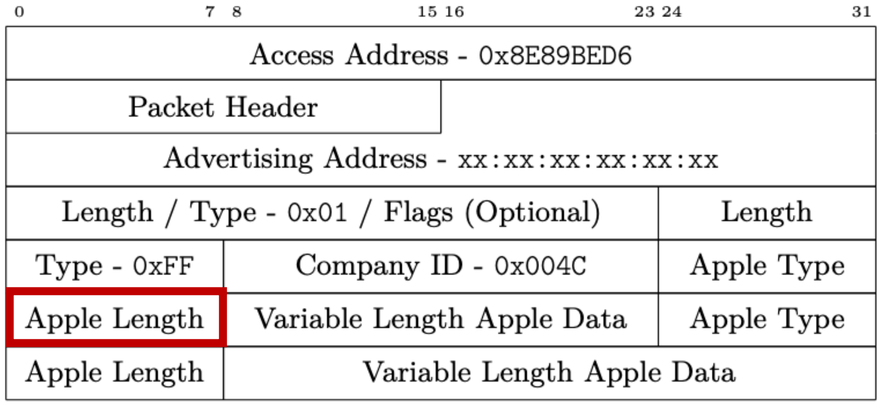
Length = 25

Separated

Bytes 6-27 of the public key

Continuity Protocol Explained

It’s not a bug, it’s a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
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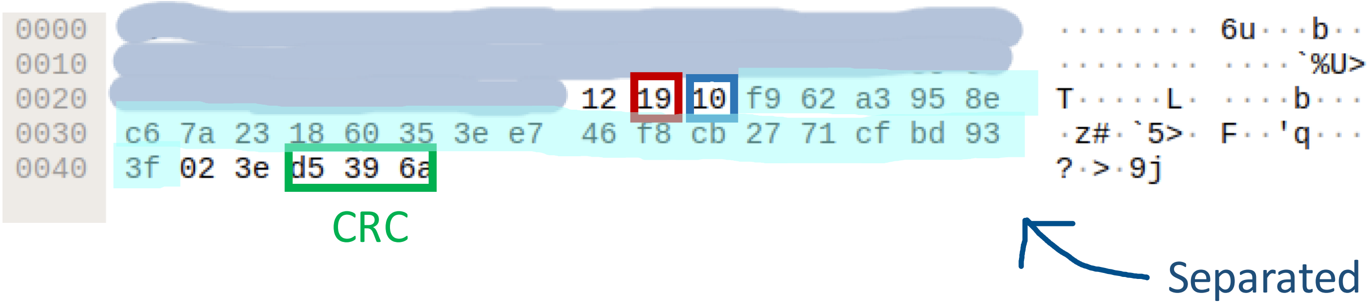
Apple BLE Frame Format



```
0000 [redacted]                                         ········  6u···b··
0010                                                    ········  ····`%U>
0020                         12 19 10 f9 62 a3 95 8e    T·····L·  ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·  F··'q···
0040 3f 02 3e d5 39 6a                                  ?·>·9j
```

Continuity Protocol Explained

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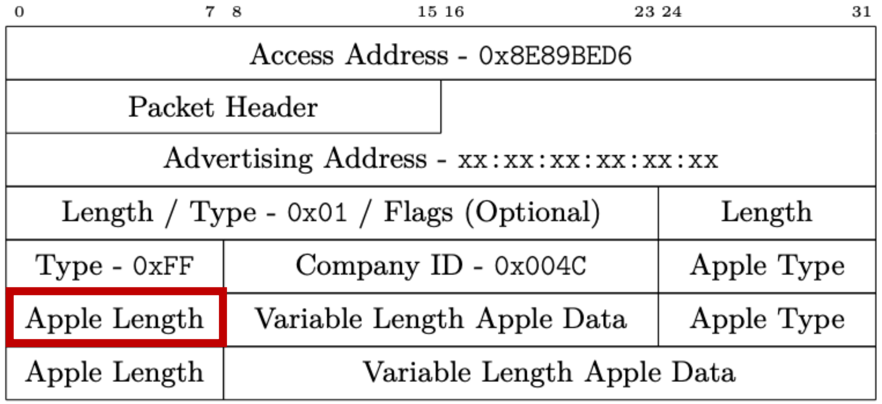
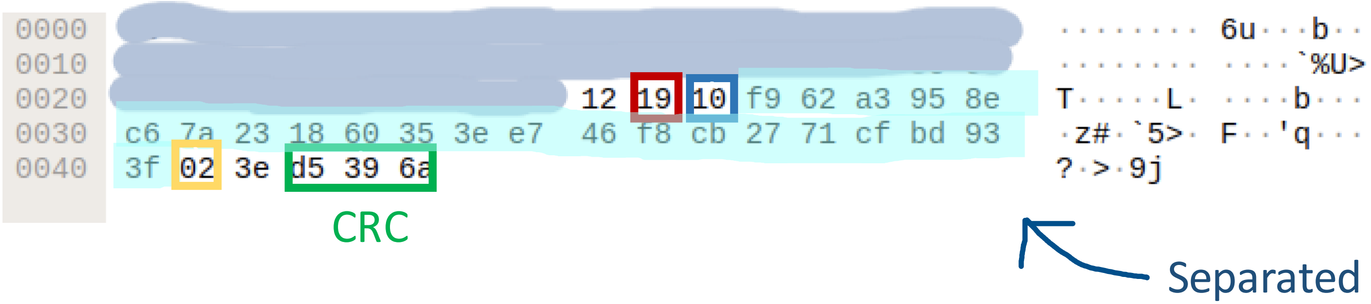


0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



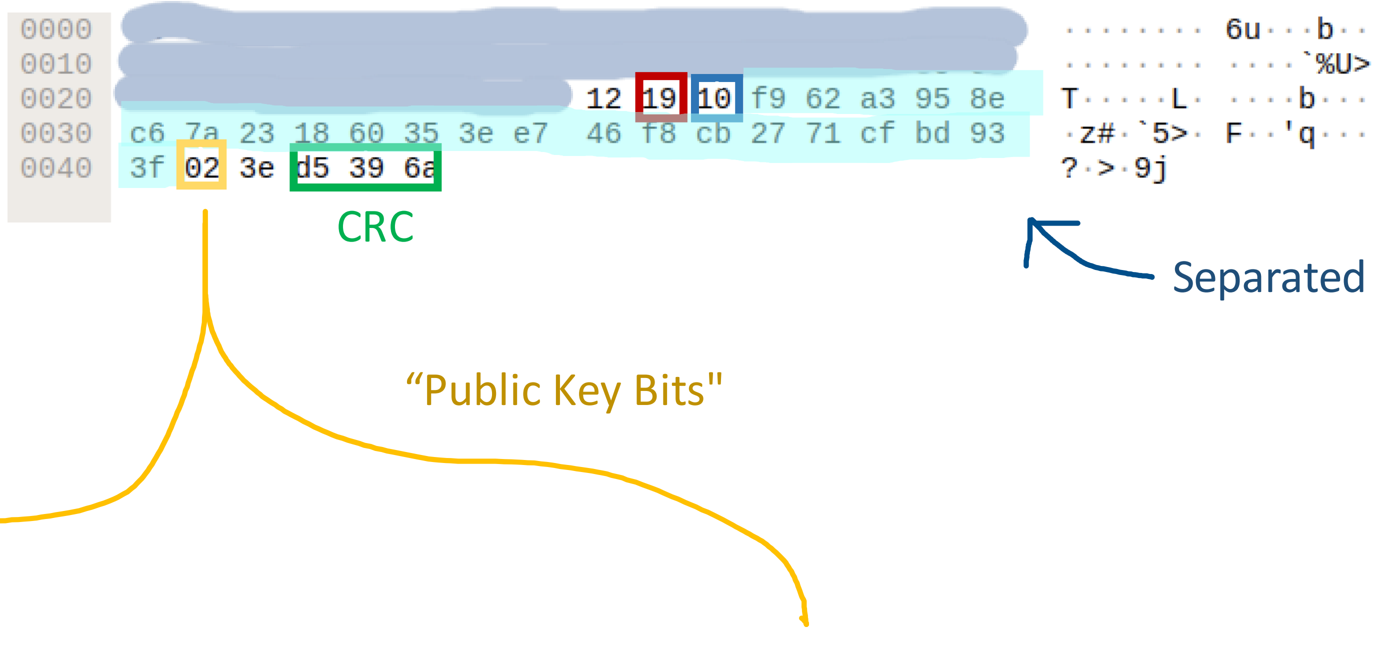
```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ········ ····`%U>
0020                           12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Continuity Protocol Explained

It's not a bug, it's a feature!

0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000 [redacted]                                        ........ 6u...b..
0010 [redacted]                                        ........ ....`%U>
0020 [redacted]            12 19 10 f9 62 a3 95 8e     T.....L. ....b...
0030 c6 7a 23 18 60 35 3e e7 46 f8 cb 27 71 cf bd 93   .z#.`5>. F..'q...
0040 3f 02 3e d5 39 6a                                 ?.>.9j
```

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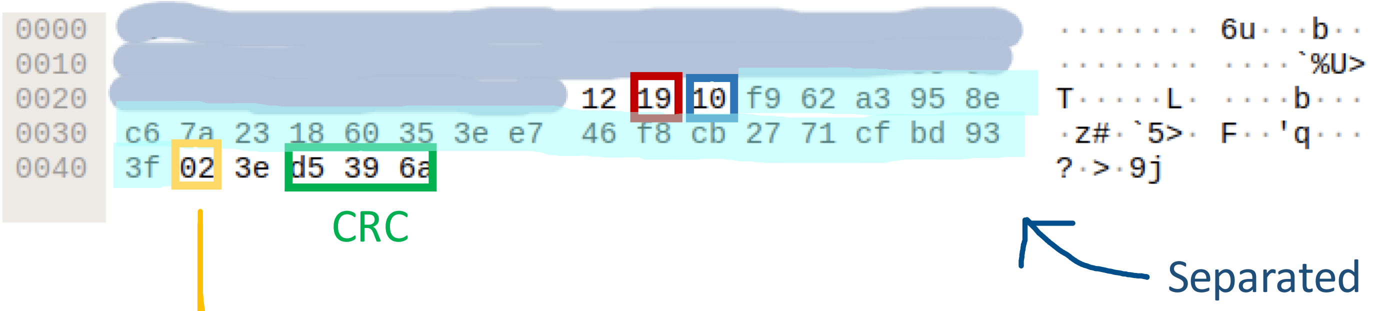
Apple BLE Frame Format



```
0000  [redacted]                                          ········ 6u···b··
0010                                                      ········ ····`%U>
0020                                12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                   ?·>·9j
```

"Public Key Bits"

7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Pub Key	Pub Key

Continuity Protocol Explained

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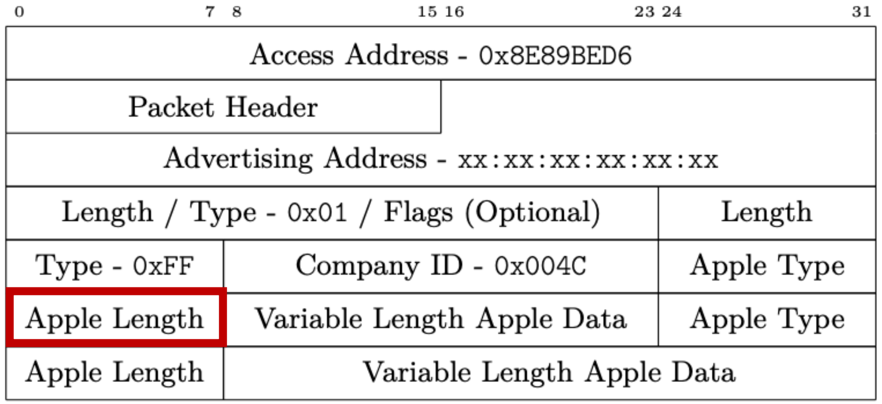
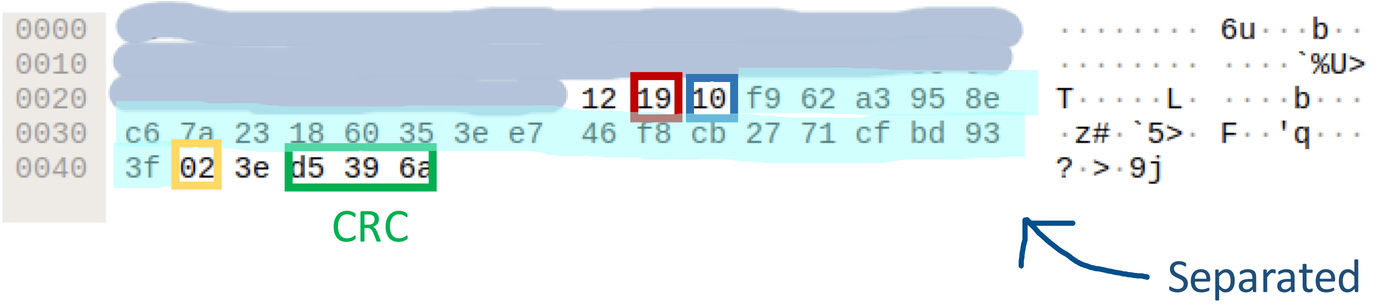


0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                          ........  6u...b..
0010  [redacted]                                          ........  ....`%U>
0020  [redacted]                12 19 10 f9 62 a3 95 8e   T.....L.  ....b...
0030  c6 7a 23 18 60 35 3e e7   46 f8 cb 27 71 cf bd 93   .z#.`5>.  F..'q...
0040  3f 02 3e d5 39 6a                                   ?.>.9j
```

CRC

Separated

Continuity Protocol Explained

It's not a bug, it's a feature!

<table>
<tr><td>0 … 7</td><td>8 … 15</td><td>16 … 23</td><td>24 … 31</td></tr>
<tr><td colspan="4">Access Address - 0x8E89BED6</td></tr>
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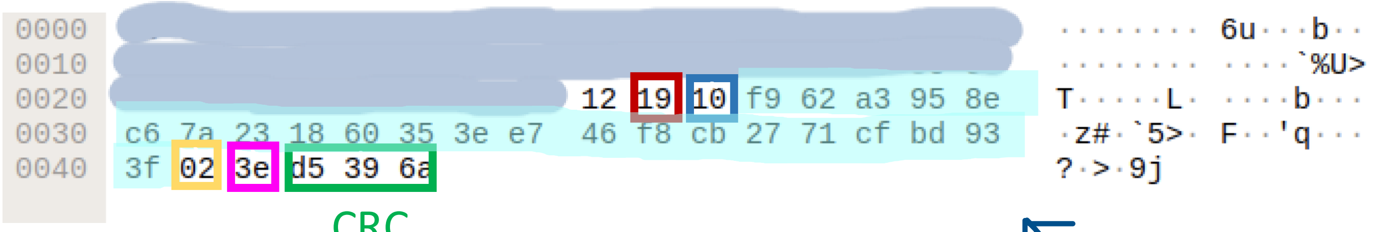
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td></tr>
</table>

Apple BLE Frame Format



```
0000  [redacted]                                         ········  6u···b··
0010                                                     ········  ····`%U>
0020                           12 19 10 f9 62 a3 95 8e   T·····L·  ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·  F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
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CRC

Separated

Continuity Protocol Explained

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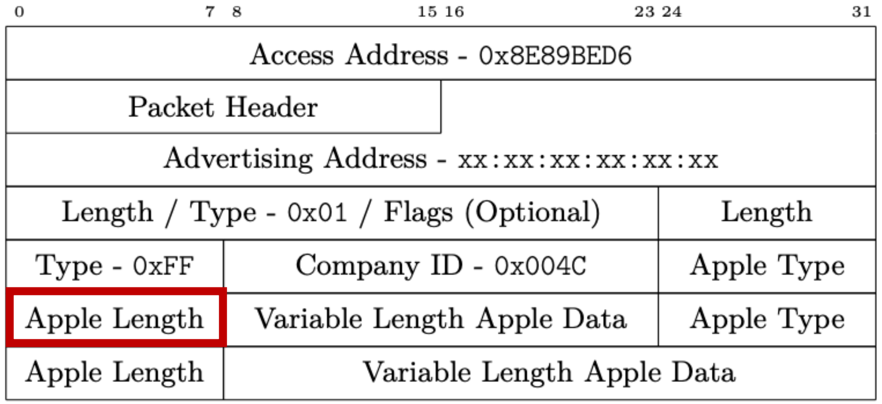
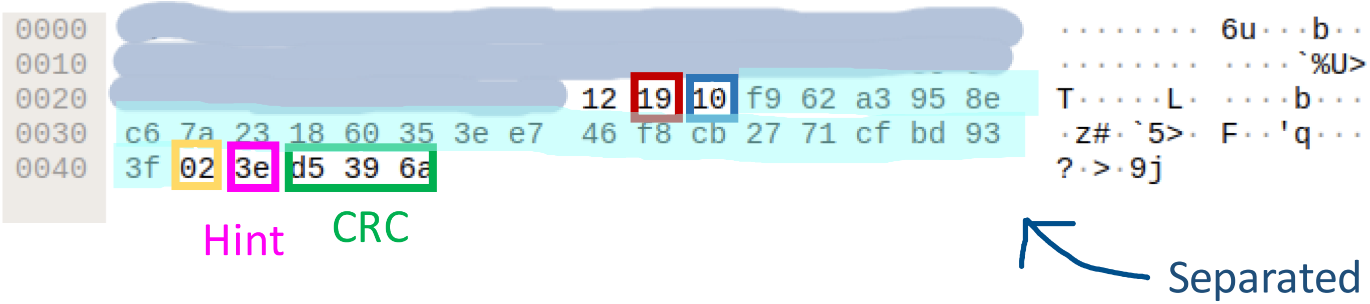


0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format



```
0000  [redacted]                                          ·········  6u···b··
0010                                                      ·········  ····`%U>
0020                                 12 19 10 f9 62 a3 95 8e   T·····L·  ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·  F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Continuity Protocol Explained

It’s not a bug, it’s a feature!

?

Continuity Protocol Explained

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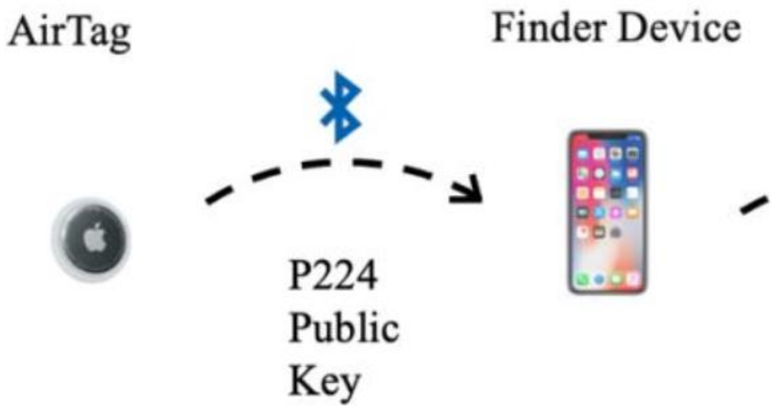

<u>28 bytes</u>

?

Continuity Protocol Explained

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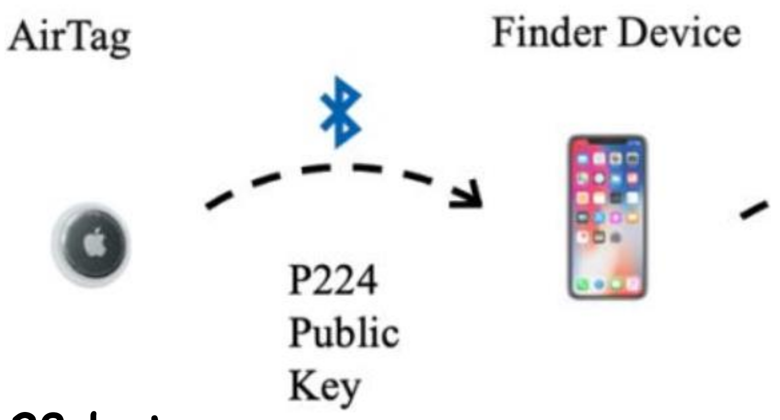
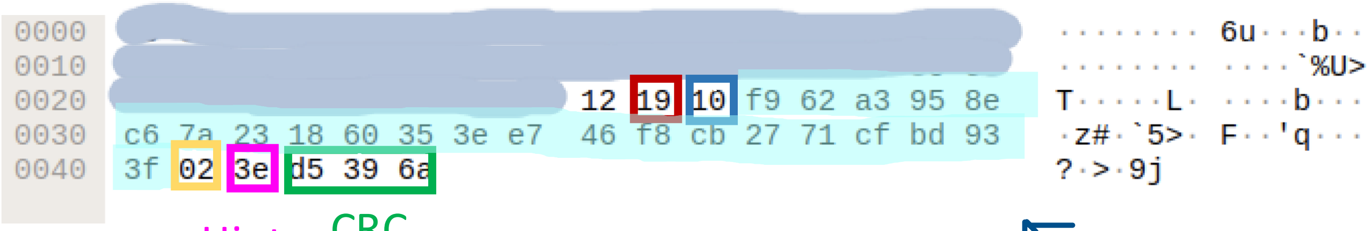


?

28 bytes



```
0000 [redacted]                                            ·········  6u···b··
0010                                                       ·········  ····`%U>
0020                          12 19 10 f9 62 a3 95 8e      T·····L·  ····b···
0030 c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93      ·z#·`5>·  F··'q···
0040 3f 02 3e d5 39 6a                                     ?·>·9j
```

Hint

CRC

Separated

Continuity Protocol Explained

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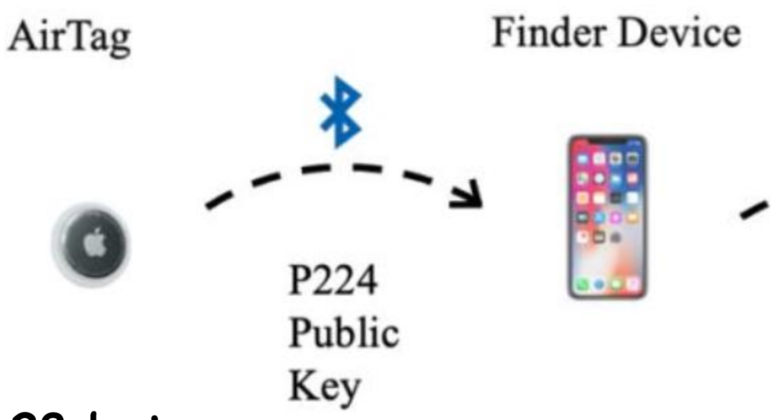
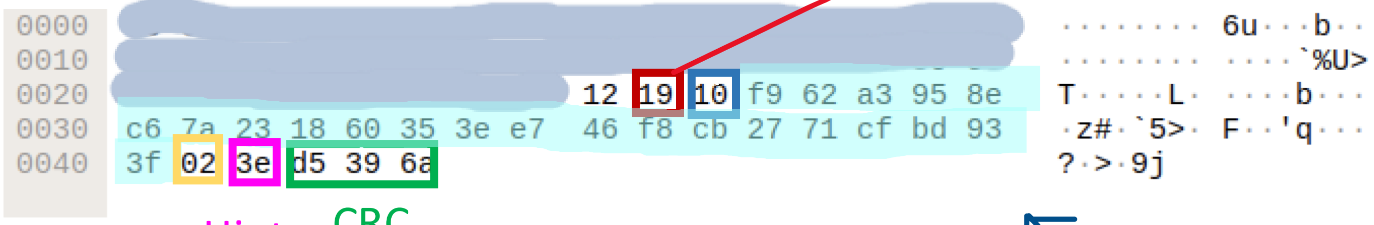


?

28 bytes



```
0000  [redacted]                                        ·········  6u···b··
0010                                                    ·········  ····`%U>
0020                            12 19 10 f9 62 a3 95 8e  T·····L·  ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>·  F··'q···
0040  3f 02 3e d5 39 6a                                 ?·>·9j
```

Hint

CRC

Separated

25 bytes

Bluetooth Limitations

- Small Packet Size vs Strong Encryption Need
  - MTU recommendation is 512 bytes (that’s including header info and payload)
  - In practice this is much smaller! And for Bluetooth low energy EVEN smaller (max recommended payload only 27 bytes)
  - BUT we want to use strong encryption, and a P-224 key of 224 bits is equivalent to an RSA key of 2048 bits
  - So Apple does something a little creative here....

Continuity Protocol Explained

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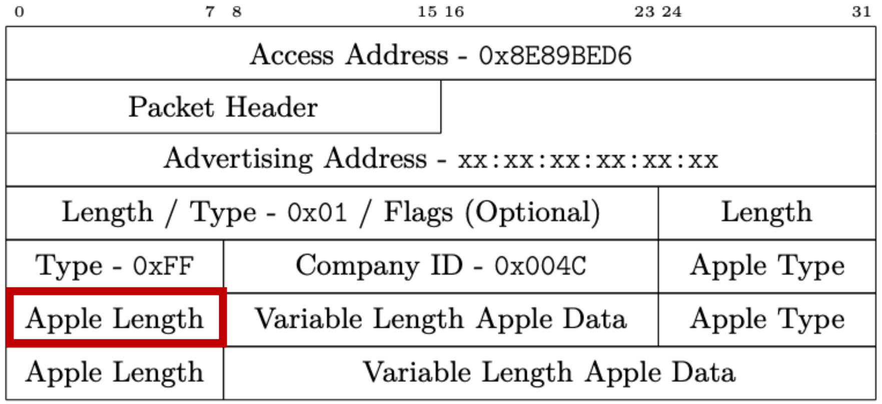
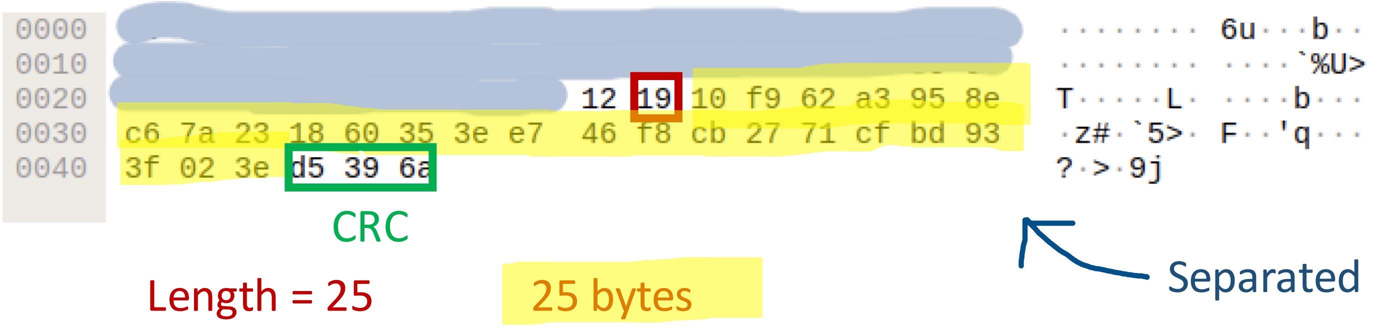


Access Address - 0x8E89BED6		
Packet Header		
Advertising Address - xx:xx:xx:xx:xx:xx		
Length / Type - 0x01 / Flags (Optional)		Length
Type - 0xFF	Company ID - 0x004C	Apple Type
Apple Length	Variable Length Apple Data	Apple Type
Apple Length	Variable Length Apple Data	

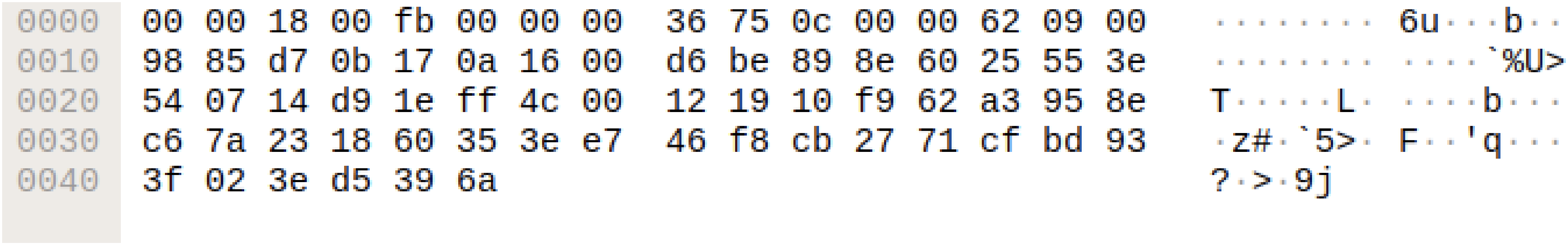
Apple BLE Frame Format



```
0000  [redacted]                                         ········ 6u··b··
0010                                                     ········ ····`%U>
0020                          12 19 10 f9 62 a3 95 8e    T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

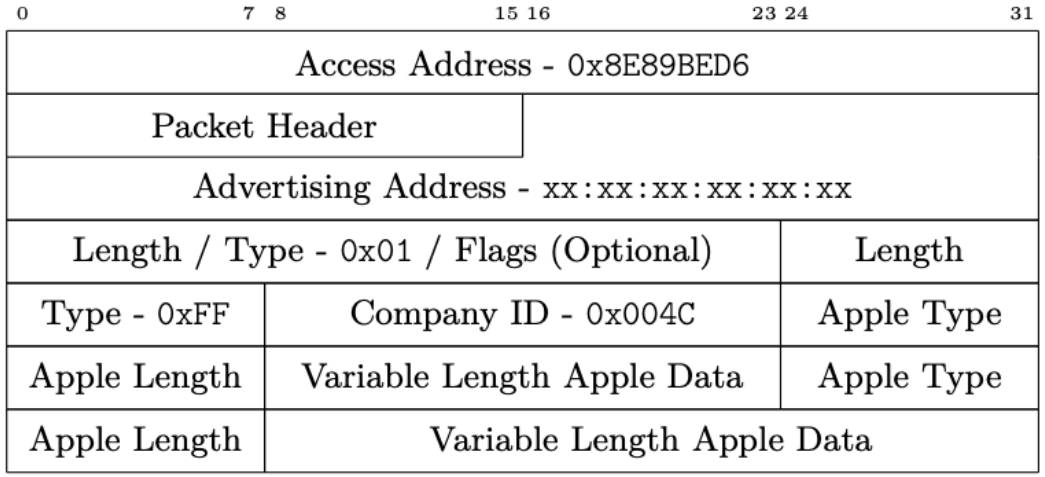
Creative Key Storage

It's not a bug, it's a feature!



```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
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Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

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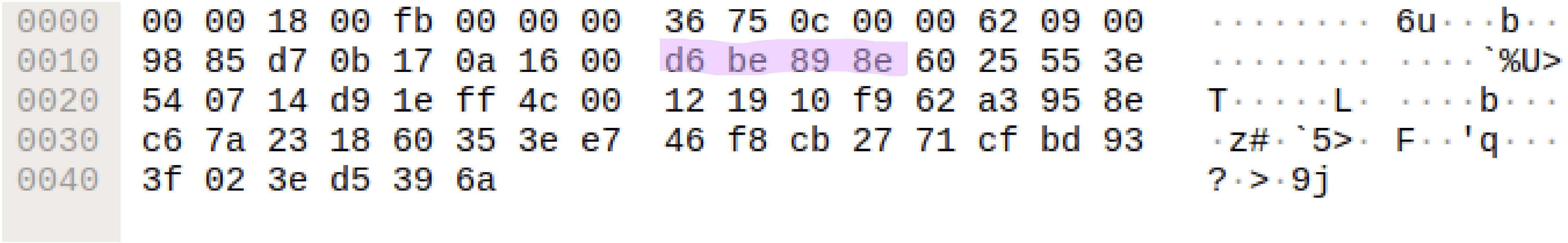
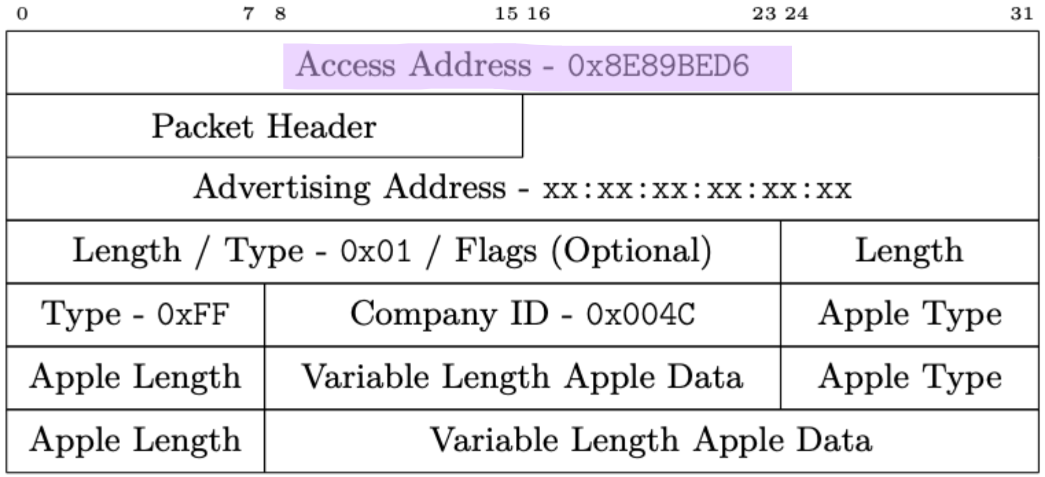


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



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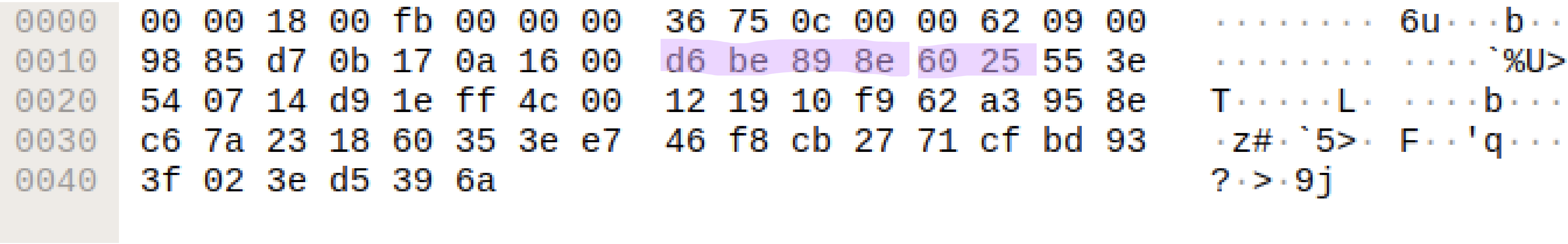
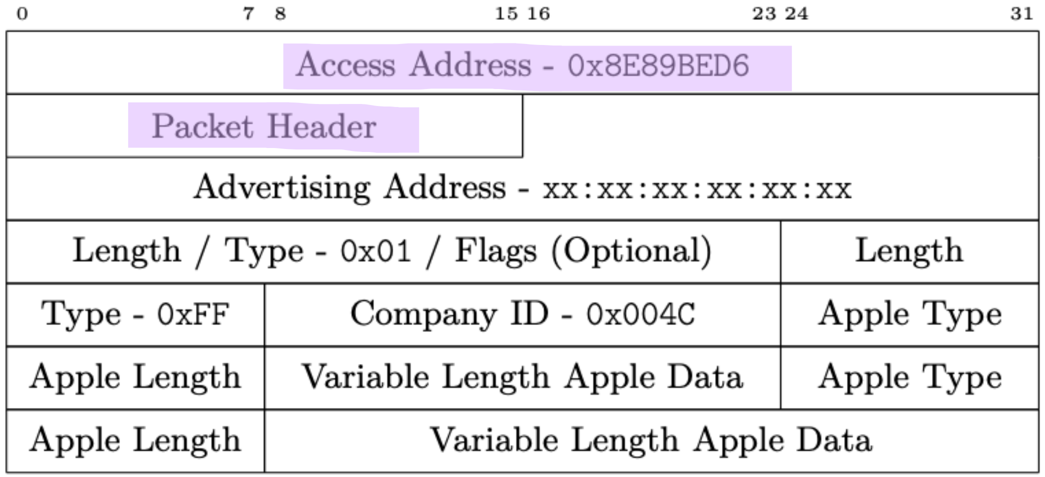


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



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Packet Header			
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Length / Type - 0x01 / Flags (Optional)			Length
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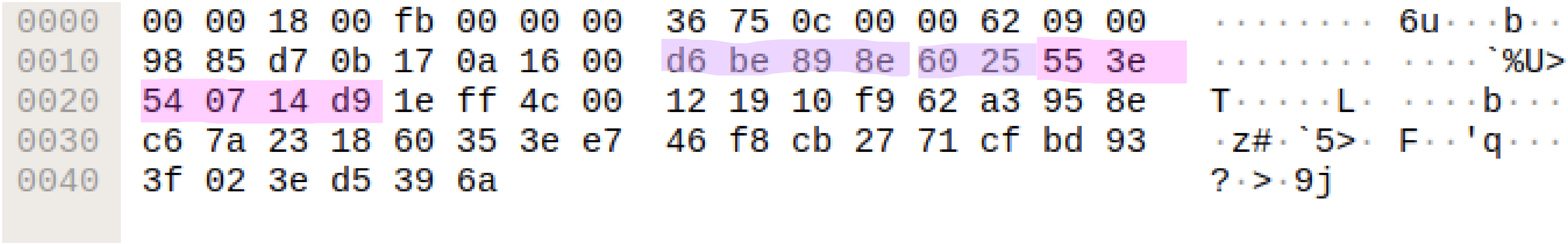
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

Creative Key Storage

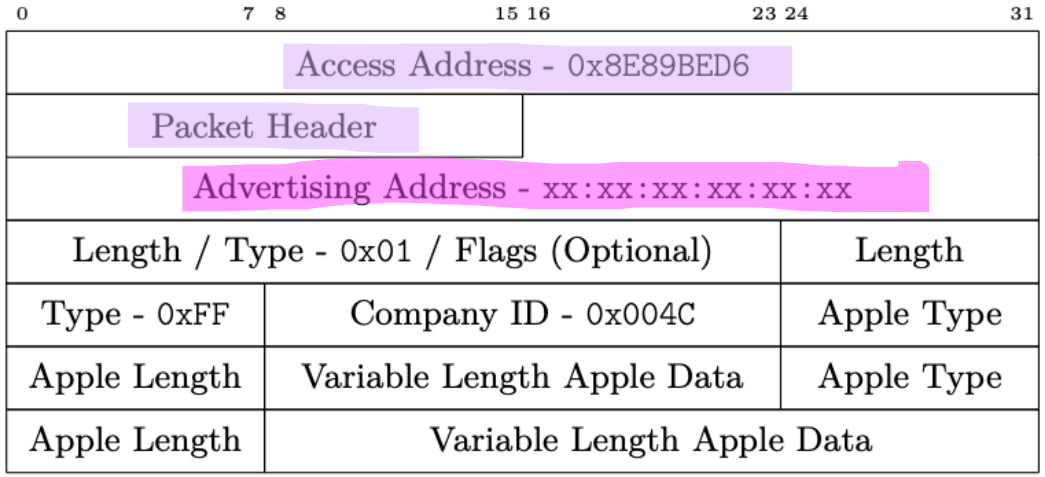
It’s not a bug, it’s a feature!

28 byte key



```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



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<tr><th>0 7</th><th>8 15</th><th>16 23</th><th>24 31</th></tr>
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<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
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</table>

Bytes 0-5

Apple BLE Frame Format

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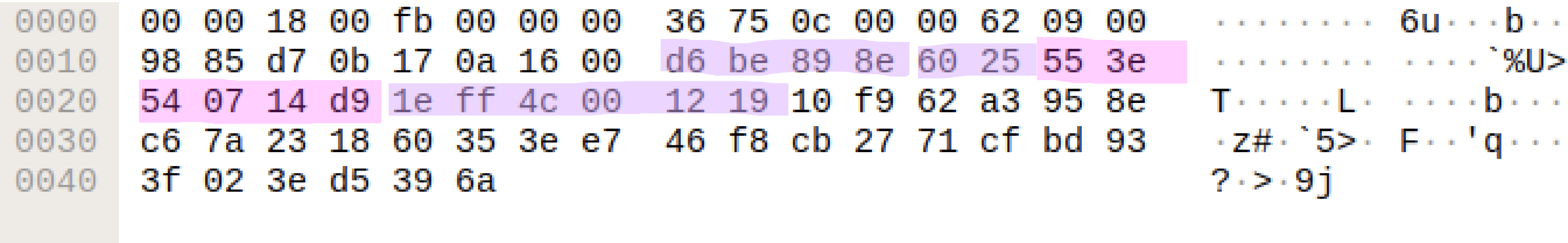
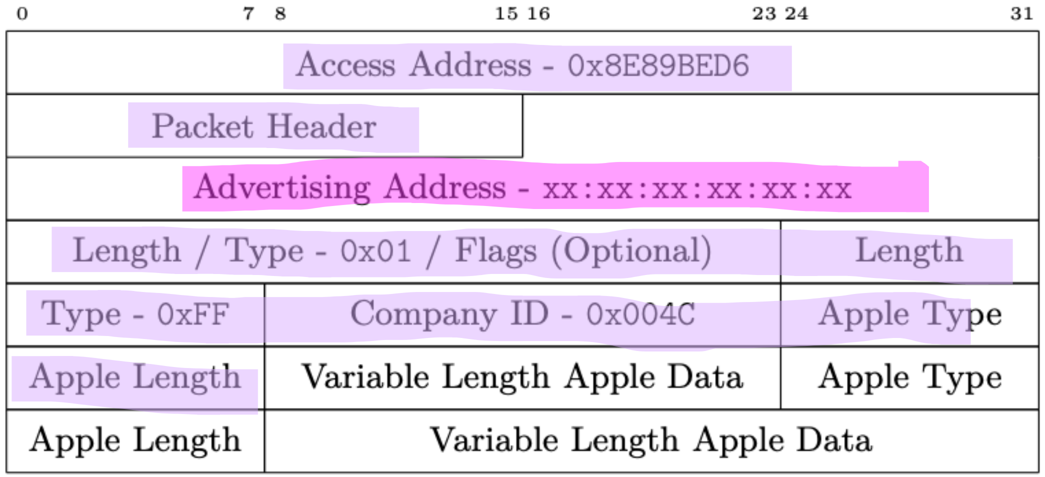


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

Bytes 0-5

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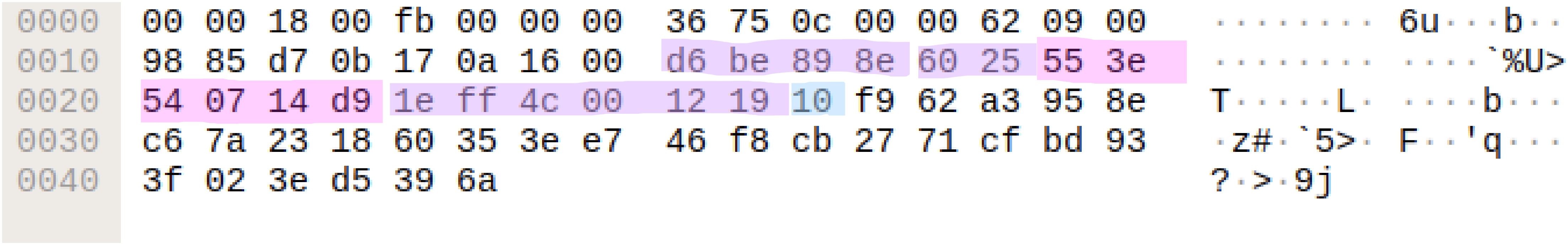
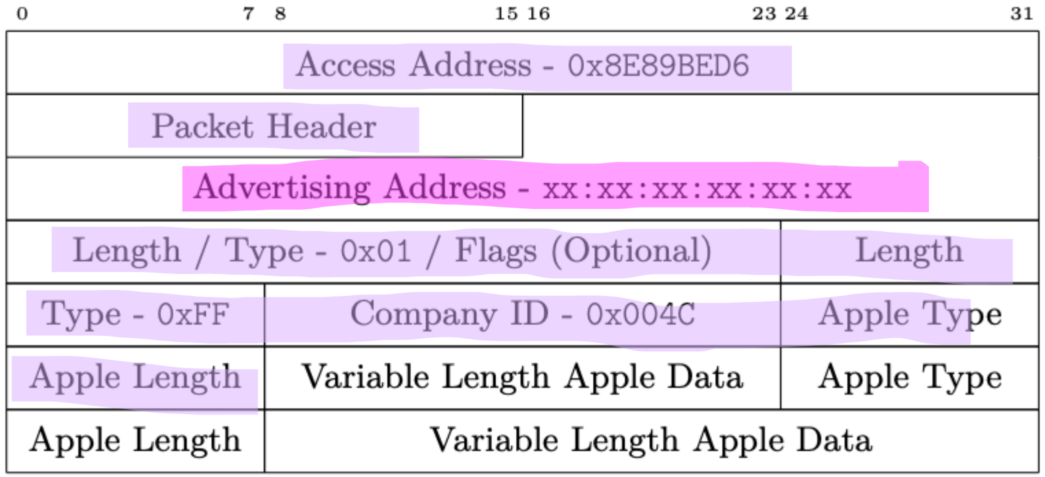


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



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Access Address - 0x8E89BED6			
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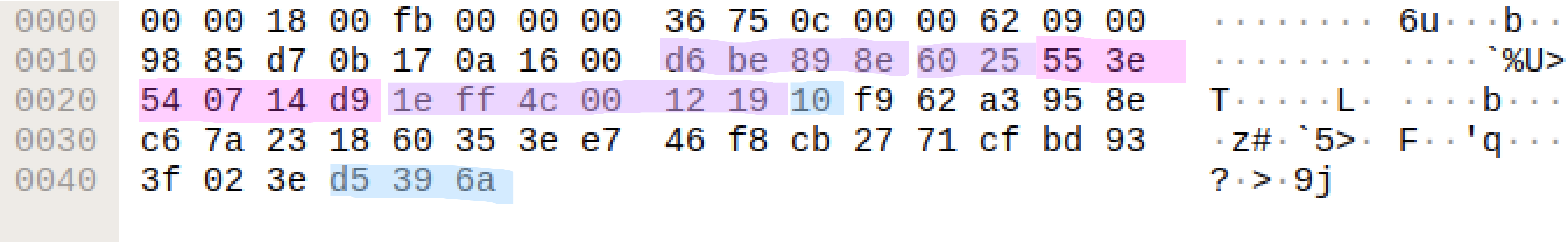
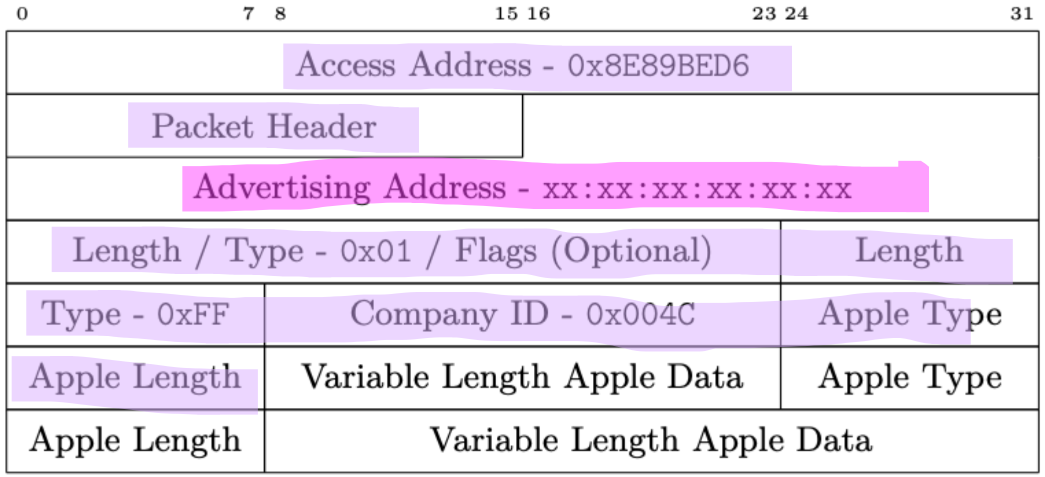


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Separated



Access Address - 0x8E89BED6		
Packet Header		
Advertising Address - xx:xx:xx:xx:xx:xx		
Length / Type - 0x01 / Flags (Optional)		Length
Type - 0xFF	Company ID - 0x004C	Apple Type
Apple Length	Variable Length Apple Data	Apple Type
Apple Length	Variable Length Apple Data	

Bytes 0-5

Apple BLE Frame Format

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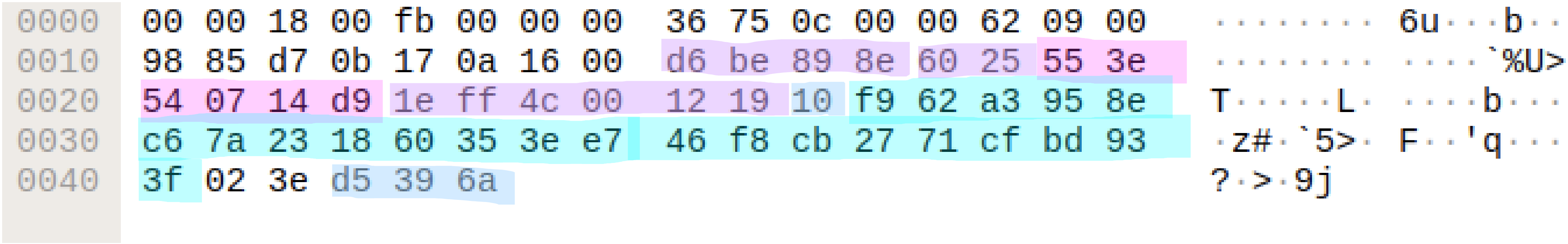
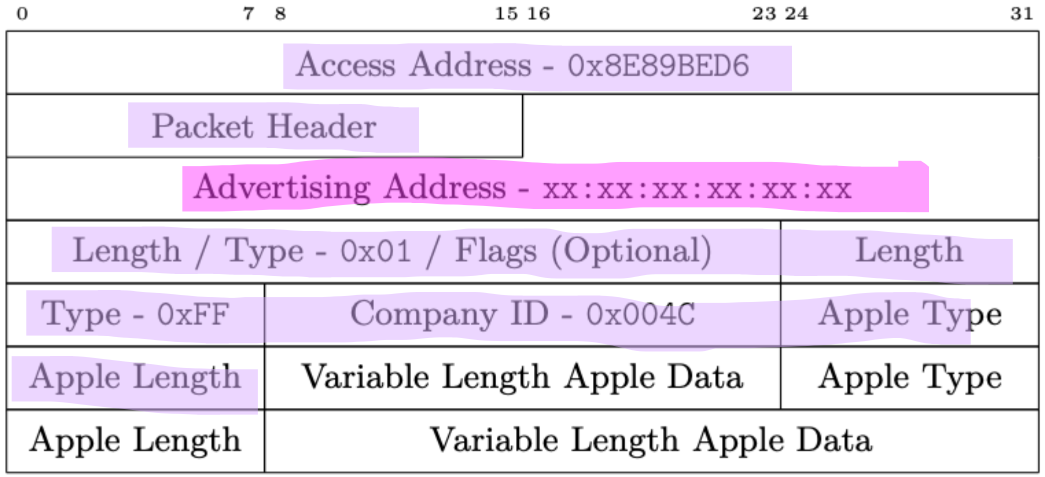


```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00  ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e  ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                 ?·>·9j
```

Separated



0
7
8
15
16
23
24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data

Bytes 0-5

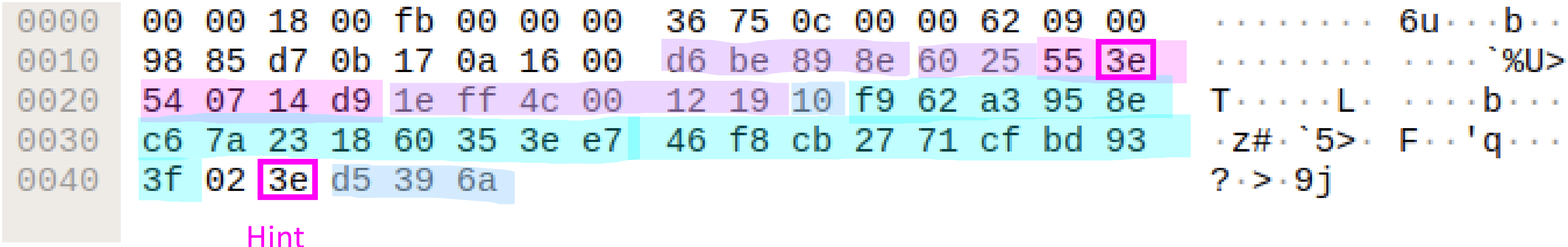
Bytes 6-27

Apple BLE Frame Format

Creative Key Storage

It’s not a bug, it’s a feature!

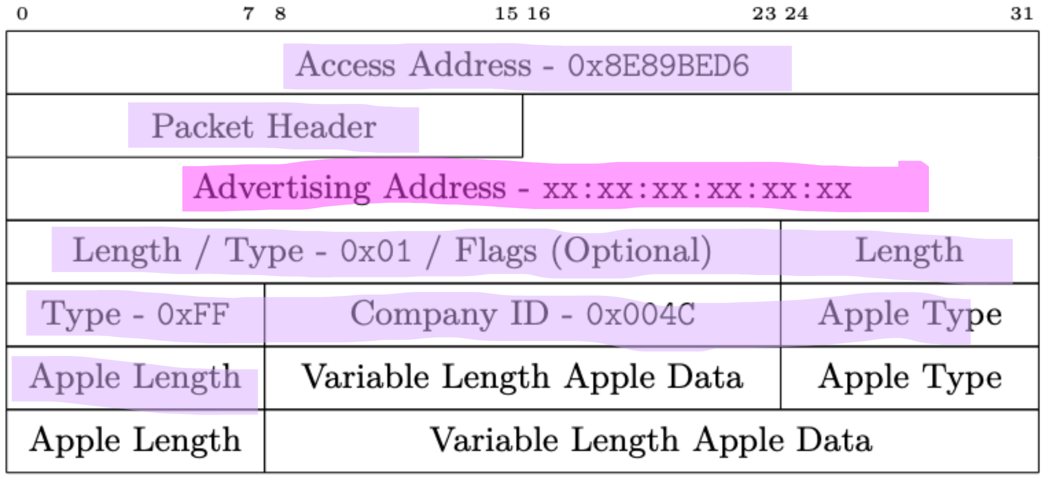
28 byte key



```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T····L·· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Hint

Separated



0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Bytes 0-5

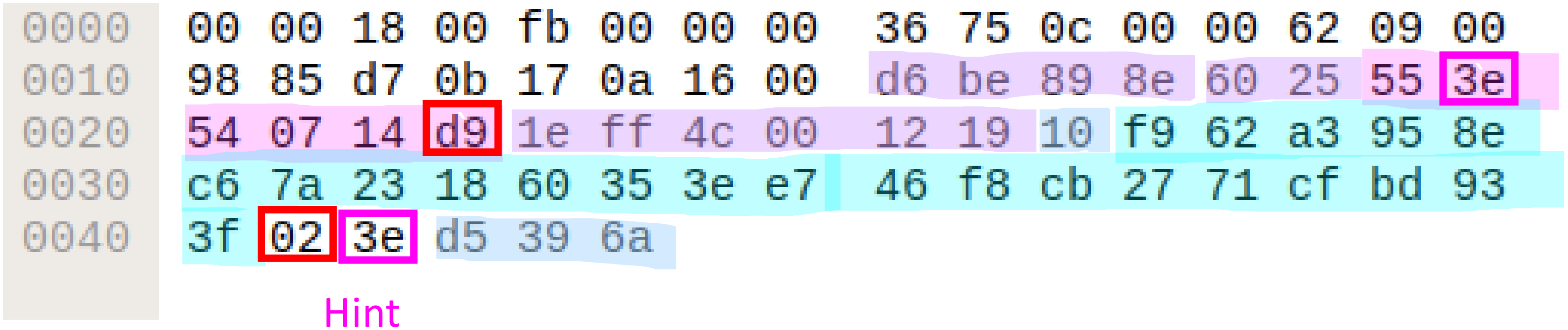
Bytes 6-27

Apple BLE Frame Format

Creative Key Storage

It’s not a bug, it’s a feature!

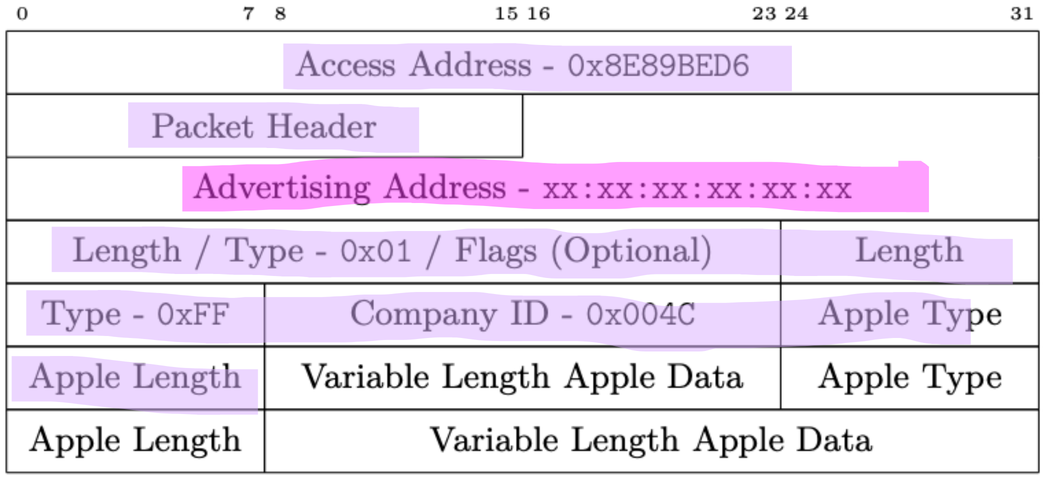
28 byte key



```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Hint

Separated



Access Address - 0x8E89BED6		
Packet Header		
Advertising Address - xx:xx:xx:xx:xx:xx		
Length / Type - 0x01 / Flags (Optional)		Length
Type - 0xFF	Company ID - 0x004C	Apple Type
Apple Length	Variable Length Apple Data	Apple Type
Apple Length	Variable Length Apple Data	

Bytes 0-5

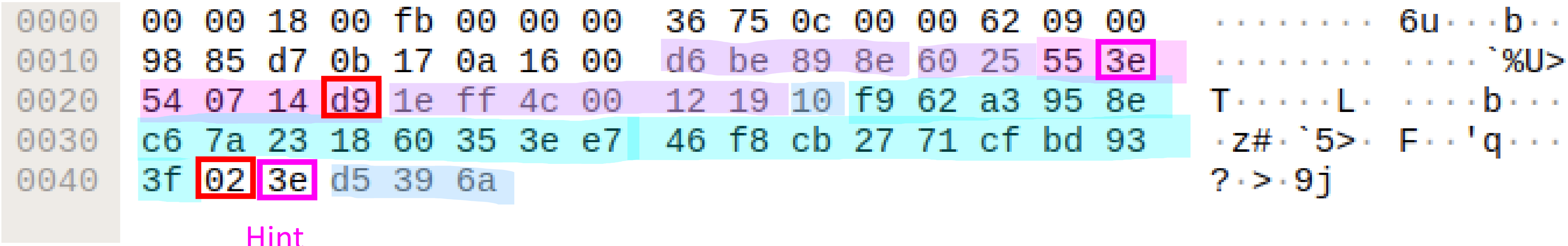
Bytes 6-27

Apple BLE Frame Format

Creative Key Storage

It's not a bug, it's a feature!

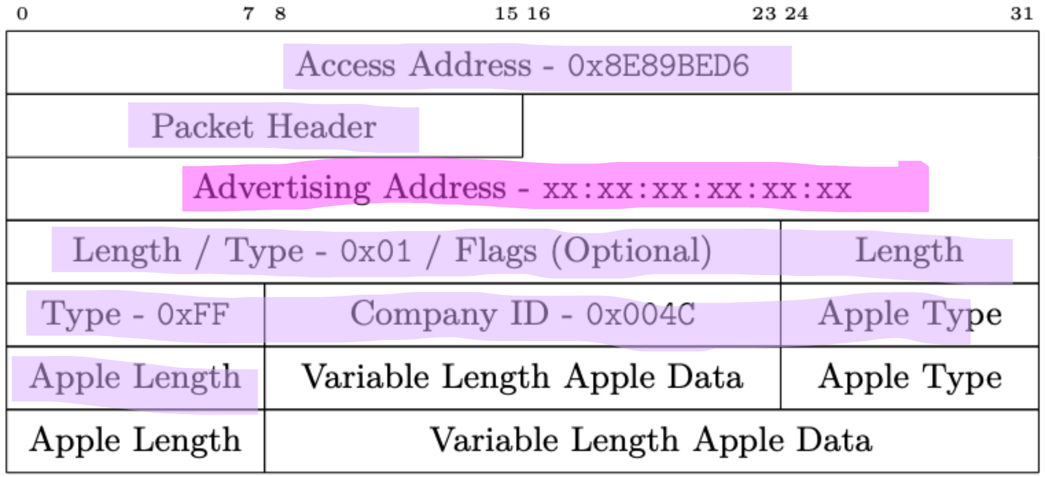
28 byte key



```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00  ········ 6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e  ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e  T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                ?·>·9j
```

Hint

Separated



Access Address - 0x8E89BED6

Packet Header

Advertising Address - xx:xx:xx:xx:xx:xx

Length / Type - 0x01 / Flags (Optional) | Length

Type - 0xFF | Company ID - 0x004C | Apple Type

Apple Length | Variable Length Apple Data | Apple Type

Apple Length | Variable Length Apple Data

Bytes 0-5

Bytes 6-27

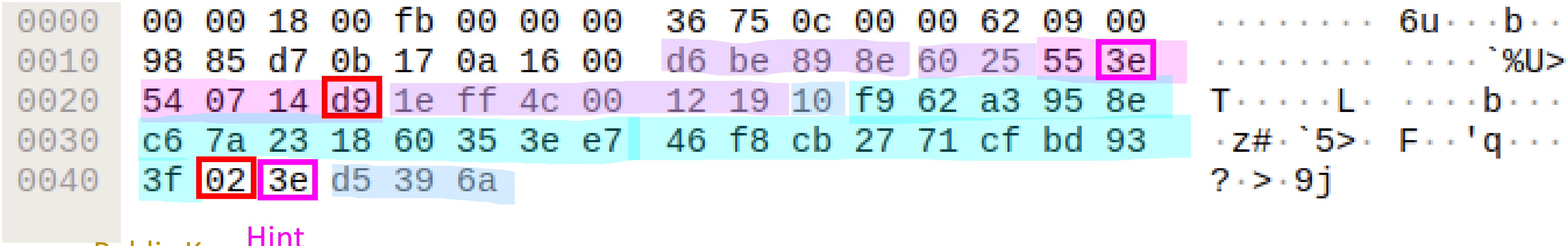
d	9
1101	1001

Apple BLE Frame Format

Creative Key Storage

It's not a bug, it's a feature!

28 byte key



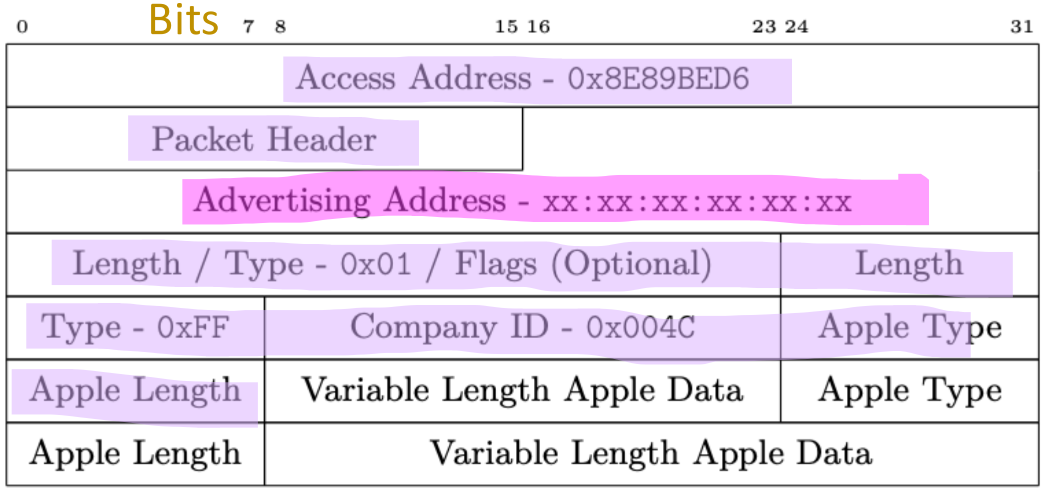
```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ············`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L·····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>·F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Public Key

Hint

Separated

Bits



Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Bytes 0-5

Bytes 6-27

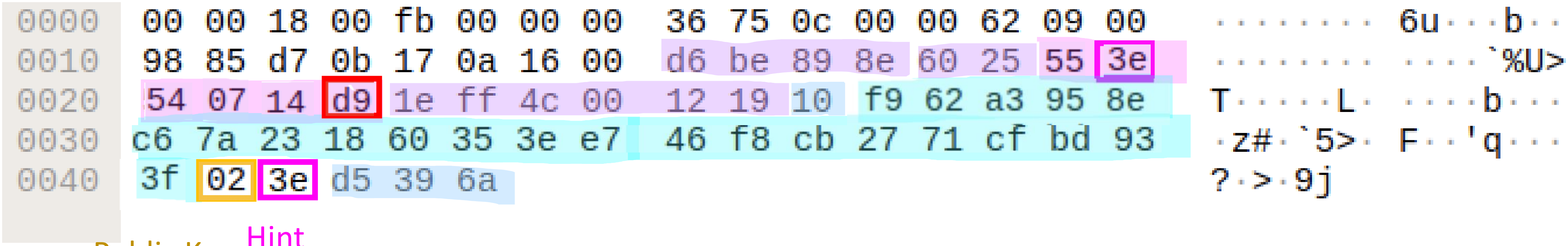
d	9
1101	1001

Apple BLE Frame Format

Creative Key Storage

It’s not a bug, it’s a feature!

28 byte key



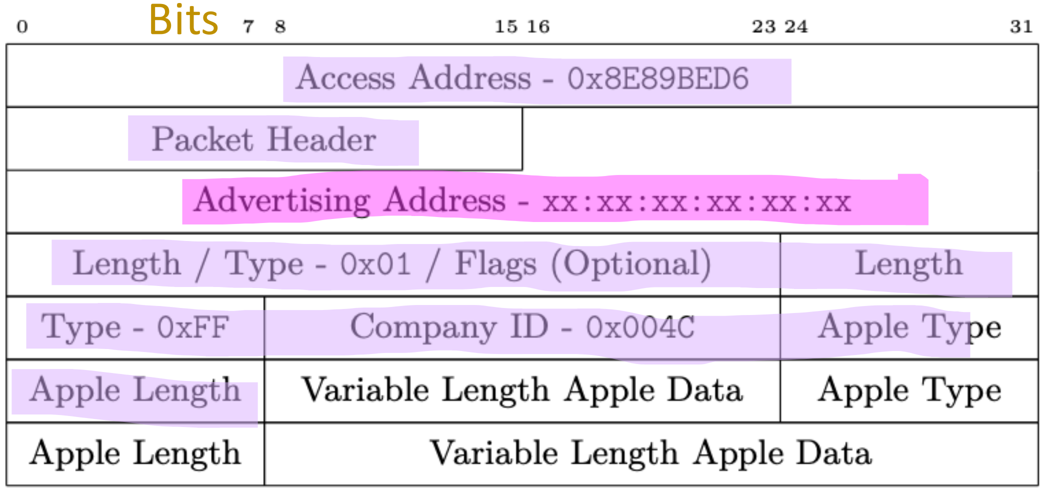
```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00  ........ 6u...b..
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e  ........ ....`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e  T.....L. ....b...
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93  .z#.`5>. F..'q...
0040  3f 02 3e d5 39 6a                                 ?.>.9j
```

Public Key

Hint

Separated

Bits



0 – 7	8 – 15	16 – 23	24 – 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Bytes 0-5

Bytes 6-27

d	9
1101	1001

→0010→10→1001→9

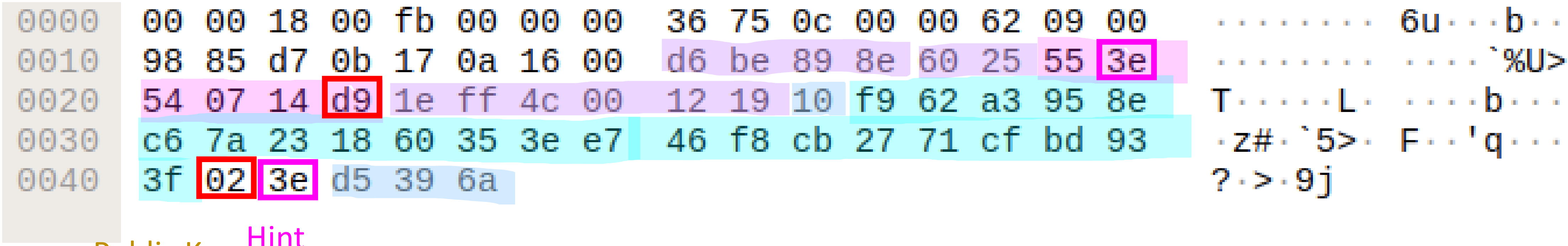
Final PubKey:

Apple BLE Frame Format

Creative Key Storage

It's not a bug, it's a feature!

28 byte key



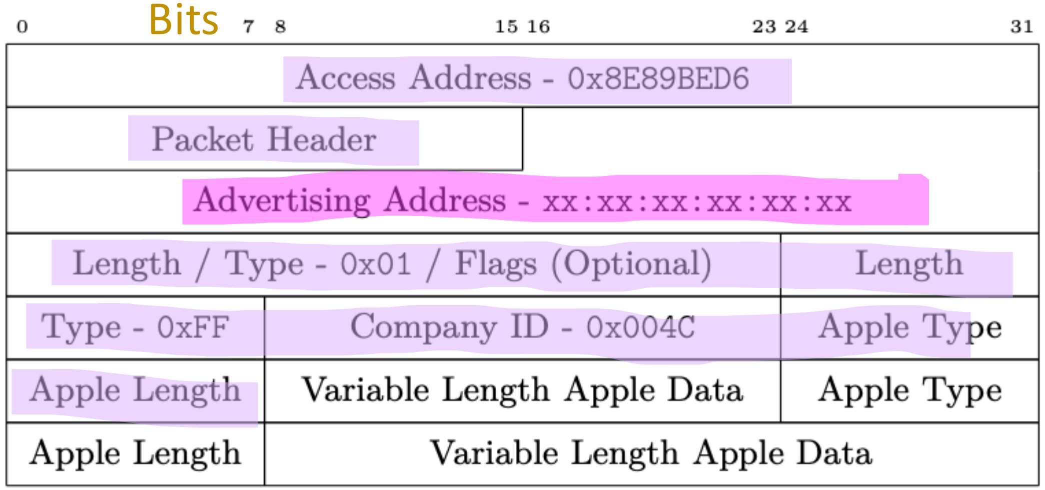
```
0000  00 00 18 00 fb 00 00 00  36 75 0c 00 00 62 09 00   ········6u···b··
0010  98 85 d7 0b 17 0a 16 00  d6 be 89 8e 60 25 55 3e   ········ ····`%U>
0020  54 07 14 d9 1e ff 4c 00  12 19 10 f9 62 a3 95 8e   T·····L· ····b···
0030  c6 7a 23 18 60 35 3e e7  46 f8 cb 27 71 cf bd 93   ·z#·`5>· F··'q···
0040  3f 02 3e d5 39 6a                                  ?·>·9j
```

Public Key

Hint

Separated

Bits



Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		

Apple BLE Frame Format

Bytes 0-5

Bytes 6-27

d	9
1101	1001

→0010→10→1001→9

Final PubKey: 991407543e55f962a3958e c67a231860353ee746f8cb2771cfbd933f

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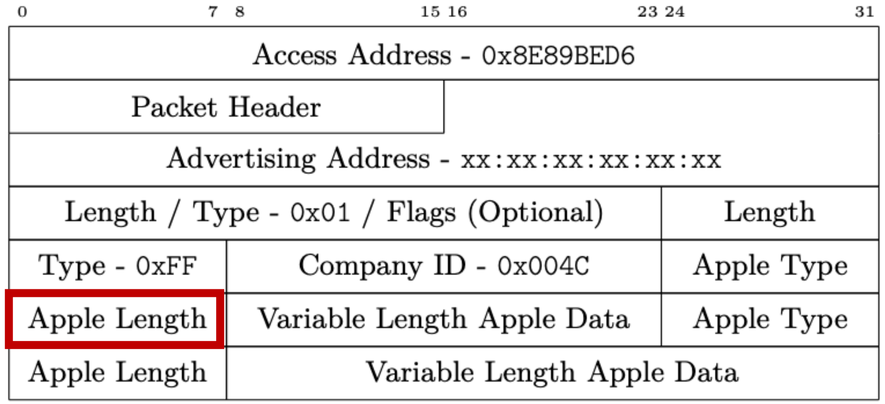
Questions?

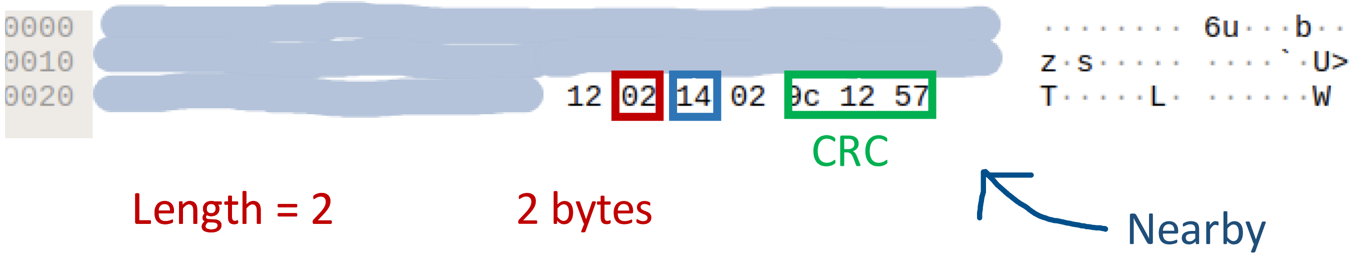
christine@herhaxpodcast.com
@x71n3 on Twitter

Continuity Protocol Explained

It's not a bug, it's a feature!



0 7	8 15	16 23	24 31
Access Address - 0x8E89BED6			
Packet Header			
Advertising Address - xx:xx:xx:xx:xx:xx			
Length / Type - 0x01 / Flags (Optional)			Length
Type - 0xFF	Company ID - 0x004C		Apple Type
Apple Length	Variable Length Apple Data		Apple Type
Apple Length	Variable Length Apple Data		



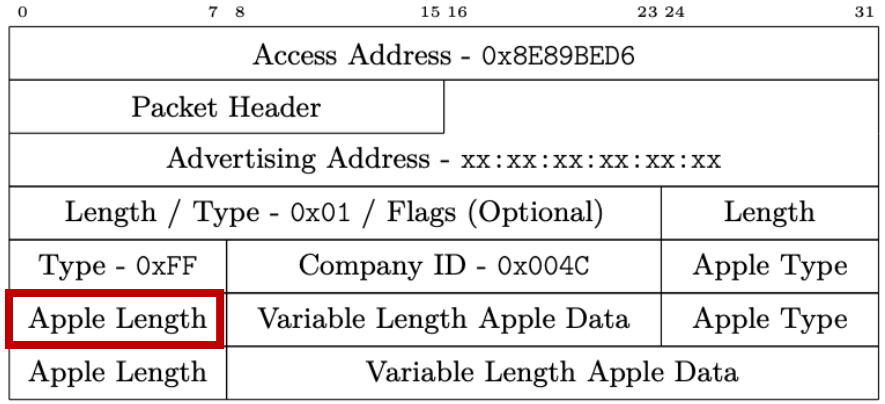
```
0000  [redacted]                     ·········  6u···b··
0010                                 z·s······  ·····`·U>
0020                12 02 14 02 9c 12 57   T······L·  ·······W
```

```
static const value_string findmy_status_vals[] = {
    { 0x00, "Owner did not connect within key rotation period (15 min.)" },
    { 0xe4, "Owner connected within key roation period, Battery Critically Low" },
    { 0xa4, "Owner connected within key roation period, Battery Low" },
    { 0x64, "Owner connected within key roation period, Battery Medium" },
    { 0x24, "Owner connected with key roation period, Battery Full" },
};
```

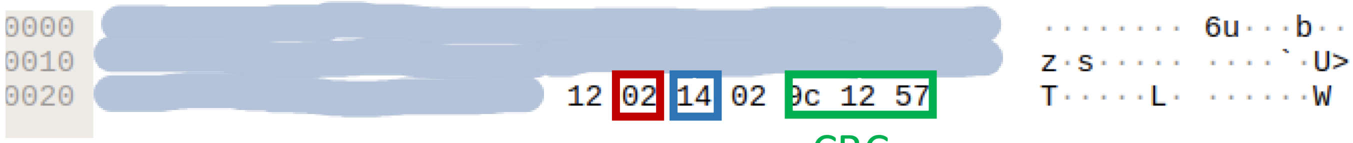
DISSECTOR CODE

Continuity Protocol Explained

It's not a bug, it's a feature!



0
7 8
15 16
23 24
31
Access Address - 0x8E89BED6
Packet Header
Advertising Address - xx:xx:xx:xx:xx:xx
Length / Type - 0x01 / Flags (Optional)
Length
Type - 0xFF
Company ID - 0x004C
Apple Type
Apple Length
Variable Length Apple Data
Apple Type
Apple Length
Variable Length Apple Data



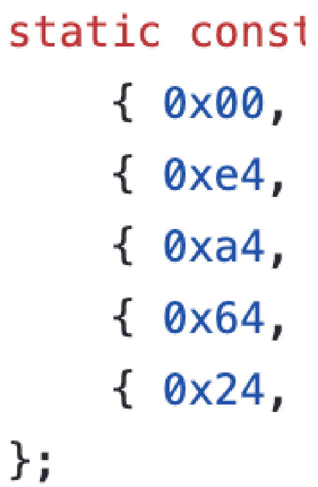
```
0000  [redacted]                                    · · · · · · · · ·  6u · · · b · ·
0010                                                z · s · · · · ·  · · · · ` · U>
0020                            12 02 14 02 0c 12 57  T · · · · · L ·  · · · · · · W
```

CRC

Length = 2

2 bytes

Nearby

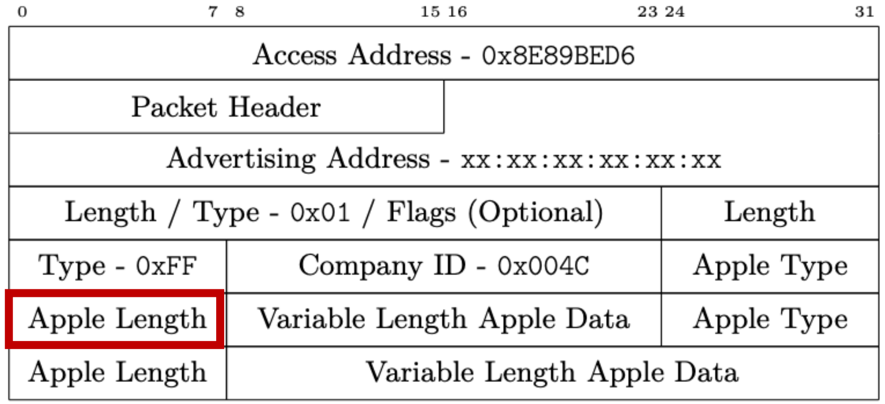


```
static const
    { 0x00,
    { 0xe4,
    { 0xa4,
    { 0x64,
    { 0x24,
};
```

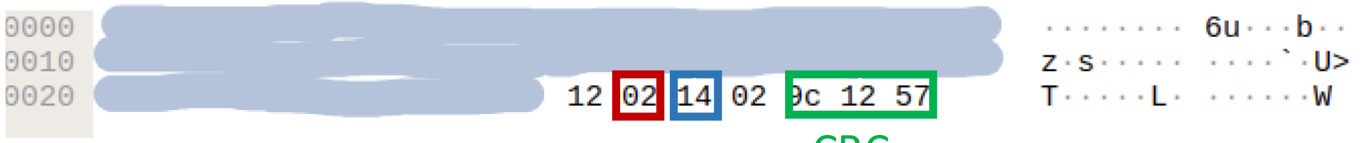
Old Left nibble	Bit 5 tracking	Bit 4 tracking	New Left nibble
0	0000	0000	0
e	1110	1101	d
a	1010	1001	9
6	0110	0101	5
2	0010	0001	1

Continuity Protocol Explained

It’s not a bug, it’s a feature!



<table>
<tr><td>0 … 7</td><td>8 … 15</td><td>16 … 23</td><td>24 … 31</td></tr>
<tr><td colspan="4">Access Address - 0x8E89BED6</td></tr>
<tr><td colspan="2">Packet Header</td><td colspan="2"></td></tr>
<tr><td colspan="4">Advertising Address - xx:xx:xx:xx:xx:xx</td></tr>
<tr><td colspan="3">Length / Type - 0x01 / Flags (Optional)</td><td>Length</td></tr>
<tr><td>Type - 0xFF</td><td colspan="2">Company ID - 0x004C</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="2">Variable Length Apple Data</td><td>Apple Type</td></tr>
<tr><td>Apple Length</td><td colspan="3">Variable Length Apple Data</td></tr>
</table>



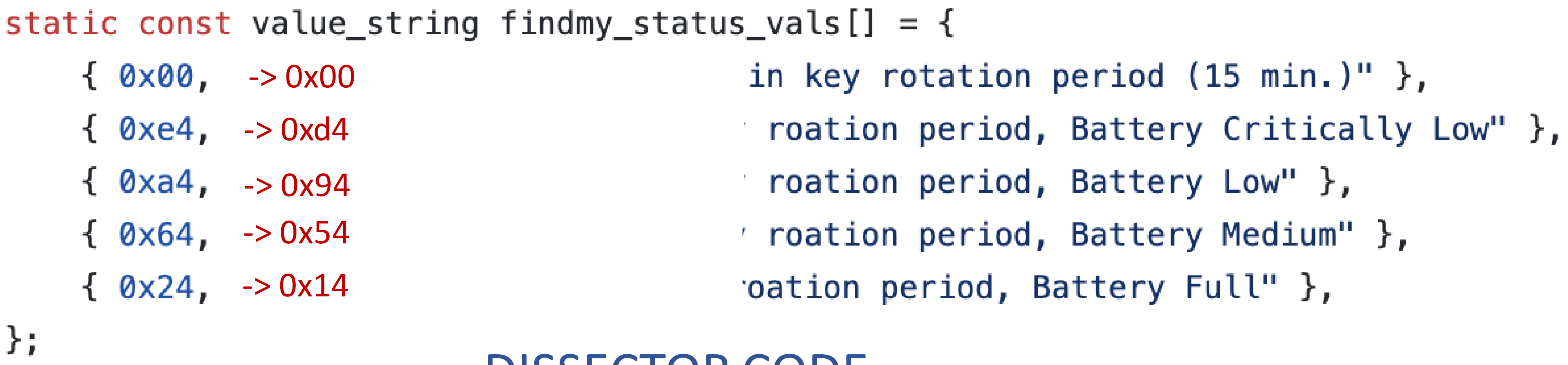
```
0000 [redacted]                                     ·········  6u···b··
0010                                                z·s······  ····`·U>
0020                          12 02 14 02 9c 12 57  T······L·  ·······W
```

CRC

Length = 2

2 bytes

Nearby



```
static const value_string findmy_status_vals[] = {
    { 0x00,   -> 0x00                         in key rotation period (15 min.)" },
    { 0xe4,   -> 0xd4                          roation period, Battery Critically Low" },
    { 0xa4,   -> 0x94                          roation period, Battery Low" },
    { 0x64,   -> 0x54                          roation period, Battery Medium" },
    { 0x24,   -> 0x14                         oation period, Battery Full" },
};
```

DISSECTOR CODE