Using own_ie_override for Custom RSN Information Elements of Beacon Frames

Goal: Manually override certain RSN-related information elements of Beacon frames sent by a LANforge system in AP Mode for testing WPA2 authentication.

In this test scenario a LANforge system acts as a WiFi access point configured to use WPA2 authentication. Beacon frames sent by this AP contain information elements about RSN encryption. The `own_ie_override` field in `hostapd.conf` provides a built-in way to override certain parts of these IEs for testing purposes, and may be configured through LANforge **Custom WiFi** parameters. Listed below are several example test cases provided in the hostap repository.

1. **Initial Setup for WPA2-Authentication Testing.**
   A. Set up a virtual AP for testing.
   In this test, it is named `vap0000` on parent device `wiphy0`.
   For more information see Create vAP in Bridge Mode

   B. On a separate radio, create a station to authenticate with `vap0000`:
   In the **Port Manager** tab, select `wiphy1` and click **Create**; select **WiFi STA**, then click **Apply**.
   In this test, the station is named `wlan1` on parent device `wiphy1`.
   For more information see Generating Traffic for WLAN Testing

   C. Configure `vap0000` and `wlan1` to use WPA2-PSK encrypted authentication.
   For more information see WPA2 Authentication Test Scenario

   D. Configure `vap0000` and `wlan1` with **SSID** `test-wpa2-psk` and **Keyphrase** `qwertyuiop`.

   E. Create a Monitor Port on its own radio to sniff wireless packets.
   In this test, the monitor port is named `moni3a`.
   For more information see Using Wireshark to Sniff WiFi Monitors

2. **Control (No Change):**
   A. Configure **Custom WiFi** in `vap0000`:
   Select `vap0000` and click **Modify**.
   Navigate to the **Custom WiFi** tab.
   Ensure that no `own_ie_override` parameter is set in **User-Specified supplicant/hostapd configuration text**.
   Click **Apply** then **OK**.

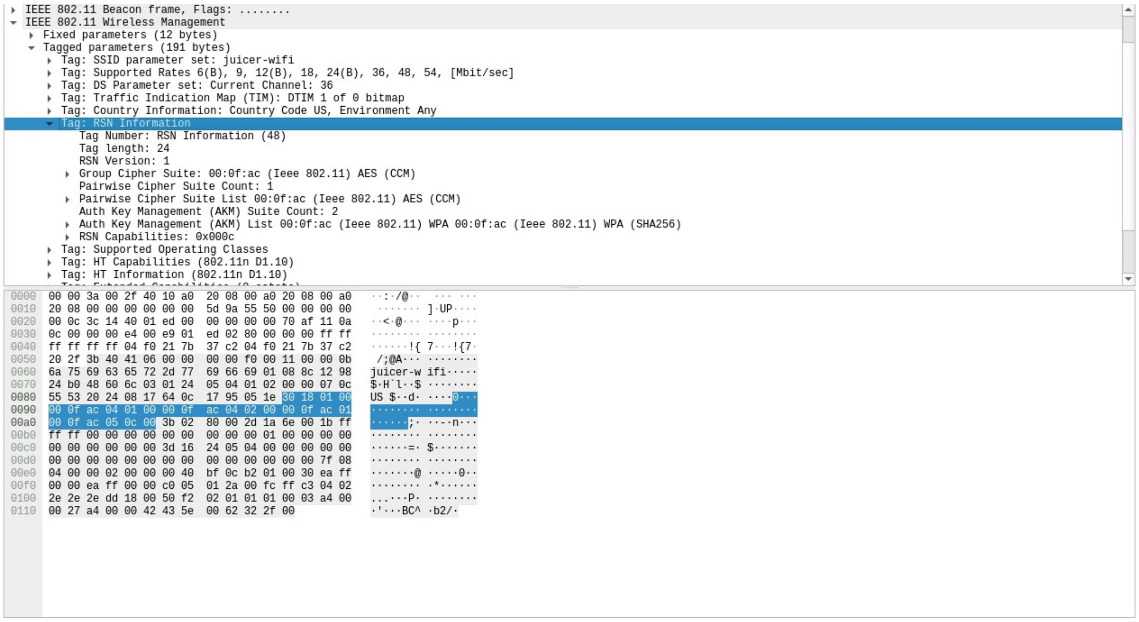
   B. Set the vAP down and back up to allow changes to take effect:
   In the **Port Manager** tab, select `vap0000`.
   Admin all selected interfaces **DOWN** (CTRL-PLUS).
   Admin all selected interfaces **UP** (CTRL-MINUS).

   C. Sniff packets to observe the authentication behavior:
   On the observation system in the **Port Manager** tab, select only `moni3a`:
   Click **Sniff Packets**.

   D. Reset the station to force re-authentication:
   In the Port Manager tab, select only `wlan1`.
   Click **Reset Port**.

   E. Observe the results, which should be similar to the following:
   - Packets are not malformed.
   - The station `wlan1` succeeds in authenticating with `vap0000`.
   - No RSN Information Element is found in Beacon frames sent by `vap0000`.

F. Example results:



```
▸ IEEE 802.11 Beacon frame, Flags: ........
▾ IEEE 802.11 Wireless Management
  ▸ Fixed parameters (12 bytes)
  ▾ Tagged parameters (191 bytes)
    ▸ Tag: SSID parameter set: juicer-wifi
    ▸ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    ▸ Tag: DS Parameter set: Current Channel: 36
    ▸ Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap
    ▸ Tag: Country Information: Country Code US, Environment Any
    ▾ Tag: RSN Information
        Tag Number: RSN Information (48)
        Tag length: 24
        RSN Version: 1
      ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
        Pairwise Cipher Suite Count: 1
      ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
        Auth Key Management (AKM) Suite Count: 2
      ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) WPA 00:0f:ac (Ieee 802.11) WPA (SHA256)
      ▸ RSN Capabilities: 0x000c
    ▸ Tag: Supported Operating Classes
    ▸ Tag: HT Capabilities (802.11n D1.10)
    ▸ Tag: HT Information (802.11n D1.10)
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  5d 9a 55 50 00 00 00 00    ········ ]·UP····
0020  00 0c 3c 14 40 01 ed 00  00 00 00 00 70 af 11 0a   ··<·@···  ····p···
0030  0c 00 00 00 e4 00 e9 01  ed 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  20 2f 3b 40 41 06 00 00  00 00 f0 00 11 00 00 0b    /;@A··· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 01 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 18 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 02 00 00 0f ac 01   ········ ········
00a0  00 0f ac 05 0c 00 3b 02  80 00 2d 1a 6e 00 1b ff   ······;· ··-·n···
00b0  ff ff 00 00 00 00 00 00  00 00 00 01 00 00 00 00   ········ ········
00c0  00 00 00 00 00 00 3d 16  24 05 04 00 00 00 00 00   ······=· $·······
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 7f 08   ········ ········
00e0  04 00 00 02 00 00 00 40  bf 0c b2 01 00 30 ea ff   ·······@ ·····0··
00f0  00 00 ea ff 00 00 c0 05  01 2a 00 fc ff c3 04 02   ········ ·*······
0100  2e 2e 2e dd 18 00 50 f2  02 01 01 01 00 03 a4 00   ...···P· ········
0110  00 27 a4 00 00 42 43 5e  00 62 32 2f 00            ·'···BC^ ·b2/·
```

3. **The RSN element used normally by hostapd:**

A. Configure **Custom WiFi** in `vap0000`:

Select `vap0000` and click **Modify**.

Navigate to the **Custom WiFi** tab.

In the **User-Specified supplicant/hostapd configuration text** field, write:

`own_ie_override=30140100000fac040100000fac040100000fac020c0`.

Click **Apply** then **OK**.

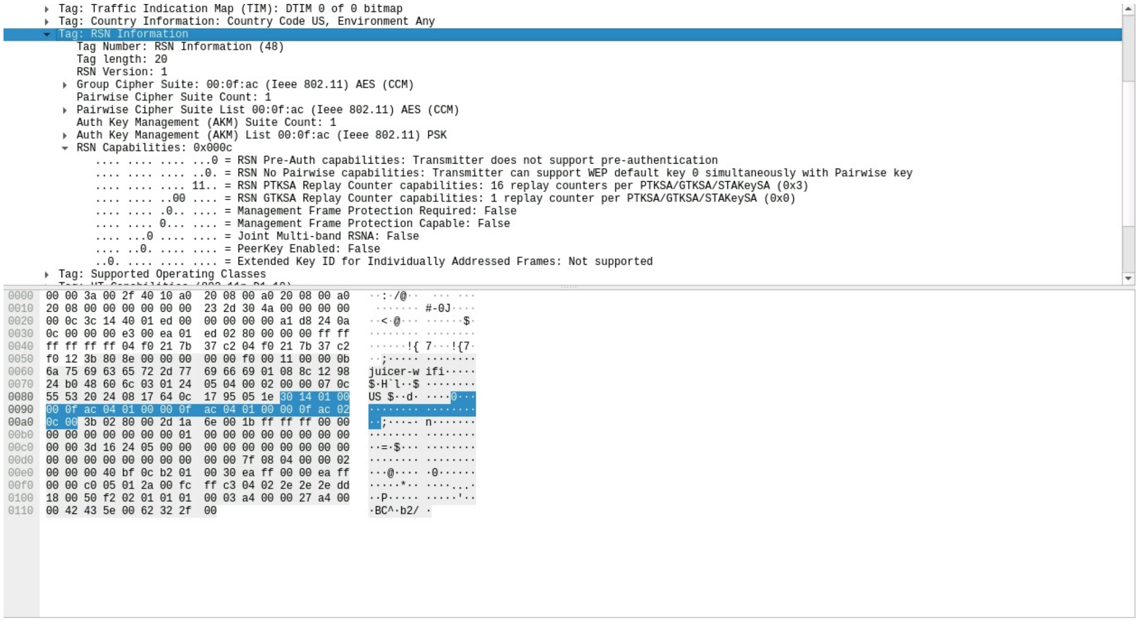
B. Reset ports and sniff packets:

Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:

- The station `wlan1` fails to authenticate with `vap0000`.
- RSN Information Element is present in Beacon frames sent by `vap0000`.

D. Example results:



```
    ▸ Tag: Traffic Indication Map (TIM): DTIM 0 of 0 bitmap
    ▸ Tag: Country Information: Country Code US, Environment Any
    ▾ Tag: RSN Information
        Tag Number: RSN Information (48)
        Tag length: 20
        RSN Version: 1
      ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
        Pairwise Cipher Suite Count: 1
      ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
        Auth Key Management (AKM) Suite Count: 1
      ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
      ▾ RSN Capabilities: 0x000c
           .... .... .... ...0 = RSN Pre-Auth capabilities: Transmitter does not support pre-authentication
           .... .... .... ..0. = RSN No Pairwise capabilities: Transmitter can support WEP default key 0 simultaneously with Pairwise key
           .... .... .... 11.. = RSN PTKSA Replay Counter capabilities: 16 replay counters per PTKSA/GTKSA/STAKeySA (0x3)
           .... .... ..00 .... = RSN GTKSA Replay Counter capabilities: 1 replay counter per PTKSA/GTKSA/STAKeySA (0x0)
           .... .... .0.. .... = Management Frame Protection Required: False
           .... .... 0... .... = Management Frame Protection Capable: False
           .... ...0 .... .... = Joint Multi-band RSNA: False
           .... ..0. .... .... = PeerKey Enabled: False
           ..0. .... .... .... = Extended Key ID for Individually Addressed Frames: Not supported
    ▸ Tag: Supported Operating Classes
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  23 2d 30 4a 00 00 00 00    ········ #-0J····
0020  00 0c 3c 14 40 01 ed 00  00 00 00 00 a1 d8 24 0a   ··<·@···  ······$·
0030  0c 00 00 00 e3 00 ea 01  ed 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  f0 12 3b 80 8e 00 00 00  00 00 f0 00 11 00 00 0b   ··;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 00 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 14 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 01 00 00 0f ac 02   ········ ········
00a0  0c 00 3b 02 80 00 2d 1a  6e 00 1b ff ff ff 00 00   ··;····- n·······
00b0  00 00 00 00 00 00 00 01  00 00 00 00 00 00 00 00   ········ ········
00c0  00 00 3d 16 24 05 00 00  00 00 00 00 00 00 00 00   ··=·$··· ········
00d0  00 00 00 00 00 00 00 00  00 00 7f 08 04 00 00 02   ········ ········
00e0  00 00 00 40 bf 0c b2 01  00 30 ea ff 00 00 ea ff   ···@···· ·0······
00f0  00 00 c0 05 01 2a 00 fc  ff c3 04 02 2e 2e 2e dd   ·····*·· ····...·
0100  18 00 50 f2 02 01 01 01  00 03 a4 00 00 27 a4 00   ··P····· ·····'··
0110  00 42 43 5e 00 62 32 2f  00                        ·BC^·b2/ ·
```

4. **No RSN Capabilities field:**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=30120100000fac040100000fac040100000fac02`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000`.
- Beacon frames sent by `vap0000` are recognizably malformed.

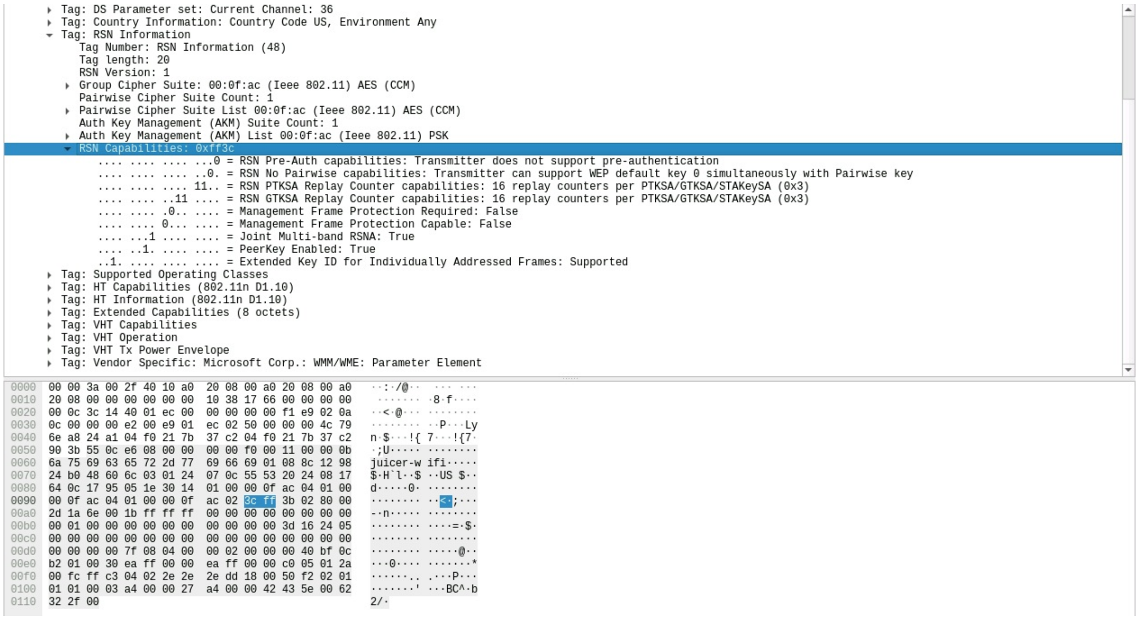
5. **Reserved RSN Capabilities bits set:**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=30140100000fac040100000fac040100000fac023cff`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- RSN Information Element is present in Beacon frames sent by `vap0000`.
- Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
  ▸ Tag: DS Parameter set: Current Channel: 36
  ▸ Tag: Country Information: Country Code US, Environment Any
  ▾ Tag: RSN Information
        Tag Number: RSN Information (48)
        Tag length: 20
        RSN Version: 1
      ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
        Pairwise Cipher Suite Count: 1
      ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
        Auth Key Management (AKM) Suite Count: 1
      ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
      ▾ RSN Capabilities: 0xff3c
            .... .... .... ...0 = RSN Pre-Auth capabilities: Transmitter does not support pre-authentication
            .... .... .... ..0. = RSN No Pairwise capabilities: Transmitter can support WEP default key 0 simultaneously with Pairwise key
            .... .... .... 11.. = RSN PTKSA Replay Counter capabilities: 16 replay counters per PTKSA/GTKSA/STAKeySA (0x3)
            .... .... ..11 .... = RSN GTKSA Replay Counter capabilities: 16 replay counters per PTKSA/GTKSA/STAKeySA (0x3)
            .... .... .0.. .... = Management Frame Protection Required: False
            .... .... 0... .... = Management Frame Protection Capable: False
            .... ...1 .... .... = Joint Multi-band RSNA: True
            .... ..1. .... .... = PeerKey Enabled: True
            ..1. .... .... .... = Extended Key ID for Individually Addressed Frames: Supported
  ▸ Tag: Supported Operating Classes
  ▸ Tag: HT Capabilities (802.11n D1.10)
  ▸ Tag: HT Information (802.11n D1.10)
  ▸ Tag: Extended Capabilities (8 octets)
  ▸ Tag: VHT Capabilities
  ▸ Tag: VHT Operation
  ▸ Tag: VHT Tx Power Envelope
  ▸ Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  10 38 17 66 00 00 00 00    ········ ·8·f····
0020  00 0c 3c 14 40 01 ec 00  00 00 00 00 f1 e9 02 0a   ··<·@··· ········
0030  0c 00 00 00 e2 00 e9 01  ec 02 50 00 00 00 4c 79   ········ ··P···Ly
0040  6e a8 24 a1 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   n·$···!{ 7···!{7·
0050  90 3b 55 0c e6 08 00 00  00 00 f0 00 11 00 00 0b   ·;U····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  07 0c 55 53 20 24 08 17   $·H`l··$ ··US $··
0080  64 0c 17 95 05 1e 30 14  01 00 00 0f ac 04 01 00   d·····0· ········
0090  00 0f ac 04 01 00 00 0f  ac 02 3c ff 3b 02 80 00   ········ ··<·;···
00a0  2d 1a 6e 00 1b ff ff ff  00 00 00 00 00 00 00 00   -·n····· ········
00b0  00 01 00 00 00 00 00 00  00 00 00 00 3d 16 24 05   ········ ····=·$·
00c0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
00d0  00 00 00 00 7f 08 04 00  00 02 00 00 00 40 bf 0c   ········ ·····@··
00e0  b2 01 00 30 ea ff 00 00  ea ff 00 00 c0 05 01 2a   ···0···· ·······*
00f0  00 fc ff c3 04 02 2e 2e  2e dd 18 00 50 f2 02 01   ······.. .···P···
0100  01 01 00 03 a4 00 00 27  a4 00 00 42 43 5e 00 62   ·······' ···BC^·b
0110  32 2f 00                                           2/·
```

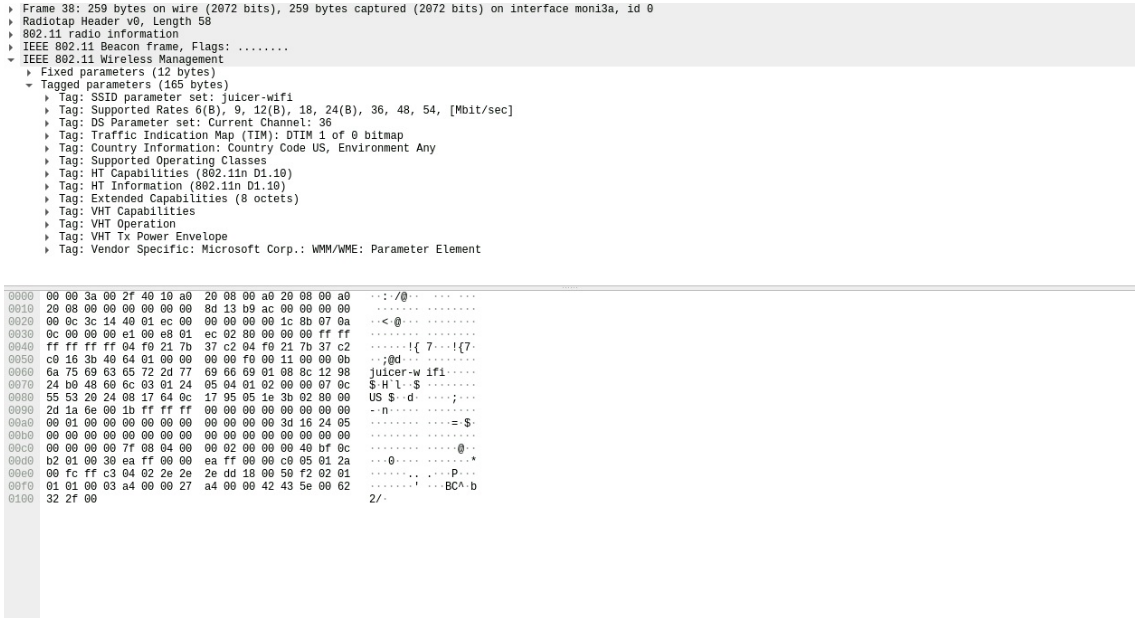
6. **Truncated RSN Capabilities field:**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=30130100000fac040100000fac040100000fac023c`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- RSN Information Element is not present in Beacon frames sent by `vap0000`.
- Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
▸ Frame 38: 259 bytes on wire (2072 bits), 259 bytes captured (2072 bits) on interface moni3a, id 0
▸ Radiotap Header v0, Length 58
▸ 802.11 radio information
▸ IEEE 802.11 Beacon frame, Flags: ........
▾ IEEE 802.11 Wireless Management
  ▸ Fixed parameters (12 bytes)
  ▾ Tagged parameters (165 bytes)
    ▸ Tag: SSID parameter set: juicer-wifi
    ▸ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
    ▸ Tag: DS Parameter set: Current Channel: 36
    ▸ Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap
    ▸ Tag: Country Information: Country Code US, Environment Any
    ▸ Tag: Supported Operating Classes
    ▸ Tag: HT Capabilities (802.11n D1.10)
    ▸ Tag: HT Information (802.11n D1.10)
    ▸ Tag: Extended Capabilities (8 octets)
    ▸ Tag: VHT Capabilities
    ▸ Tag: VHT Operation
    ▸ Tag: VHT Tx Power Envelope
    ▸ Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  8d 13 b9 ac 00 00 00 00    ······· ········
0020  00 0c 3c 14 40 01 ec 00  00 00 00 00 1c 8b 07 0a   ··<·@··· ········
0030  0c 00 00 00 e1 00 e8 01  ec 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  c0 16 3b 40 64 01 00 00  00 00 f0 00 11 00 00 0b   ··;@d··· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 01 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 3b 02 80 00   US $··d· ····;···
0090  2d 1a 6e 00 1b ff ff ff  00 00 00 00 00 00 00 00   -·n····· ········
00a0  00 01 00 00 00 00 00 00  00 00 00 00 3d 16 24 05   ········ ····=·$·
00b0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
00c0  00 00 00 00 7f 08 04 00  00 02 00 00 00 40 bf 0c   ········ ·····@··
00d0  b2 01 00 30 ea ff 00 00  ea ff 00 00 c0 05 01 2a   ···0···· ·······*
00e0  00 fc ff c3 04 02 2e 2e  2e dd 18 00 50 f2 02 01   ······.. .···P···
00f0  01 01 00 03 a4 00 00 27  a4 00 00 42 43 5e 00 62   ·······' ···BC^·b
0100  32 2f 00                                           2/·
```

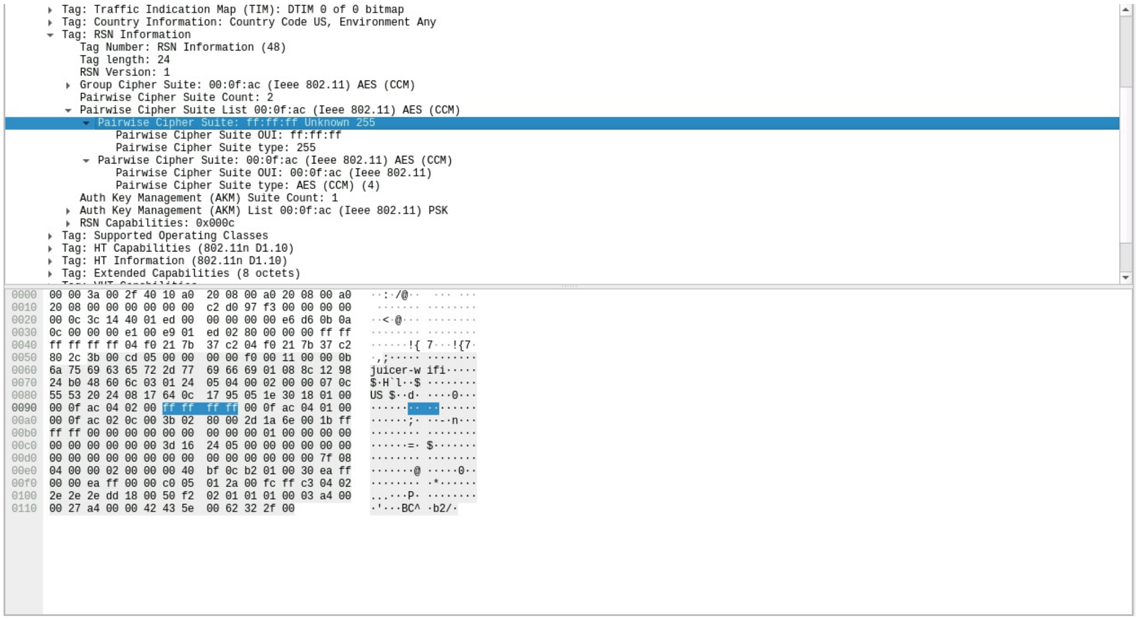
7. **Extra pairwise cipher suite (unsupported):**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=30180100000fac040200ffffffff000fac040100000fac020c00`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- RSN Information Element is present in Beacon frames sent by `vap0000`.
- Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
    ▸ Tag: Traffic Indication Map (TIM): DTIM 0 of 0 bitmap
    ▸ Tag: Country Information: Country Code US, Environment Any
    ▾ Tag: RSN Information
        Tag Number: RSN Information (48)
        Tag length: 24
        RSN Version: 1
      ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
        Pairwise Cipher Suite Count: 2
      ▾ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
        ▾ Pairwise Cipher Suite: ff:ff:ff Unknown 255
            Pairwise Cipher Suite OUI: ff:ff:ff
            Pairwise Cipher Suite type: 255
        ▾ Pairwise Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
            Pairwise Cipher Suite OUI: 00:0f:ac (Ieee 802.11)
            Pairwise Cipher Suite type: AES (CCM) (4)
        Auth Key Management (AKM) Suite Count: 1
      ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
      ▸ RSN Capabilities: 0x000c
    ▸ Tag: Supported Operating Classes
    ▸ Tag: HT Capabilities (802.11n D1.10)
    ▸ Tag: HT Information (802.11n D1.10)
    ▸ Tag: Extended Capabilities (8 octets)
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  c2 d0 97 f3 00 00 00 00    ······· ········
0020  00 0c 3c 14 40 01 ed 00  00 00 00 00 e6 d6 0b 0a   ··<·@··· ········
0030  0c 00 00 00 e1 00 e9 01  ed 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  80 2c 3b 00 cd 05 00 00  00 00 f0 00 11 00 00 0b   ·,;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 00 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 18 01 00   US $··d· ····0···
0090  00 0f ac 04 02 00 ff ff  ff ff 00 0f ac 04 01 00   ········ ········
00a0  00 0f ac 02 0c 00 3b 02  80 00 2d 1a 6e 00 1b ff   ······;· ··-·n···
00b0  ff ff 00 00 00 00 00 00  00 00 00 01 00 00 00 00   ········ ········
00c0  00 00 00 00 00 00 3d 16  24 05 00 00 00 00 00 00   ······=· $·······
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 7f 08   ········ ········
00e0  04 00 00 02 00 00 00 40  bf 0c b2 01 00 30 ea ff   ·······@ ·····0··
00f0  00 00 ea ff 00 00 c0 05  01 2a 00 fc ff c3 04 02   ········ ·*······
0100  2e 2e 2e dd 18 00 50 f2  02 01 01 01 00 03 a4 00   ...···P· ········
0110  00 27 a4 00 00 42 43 5e  00 62 32 2f 00            ·'···BC^ ·b2/·
```

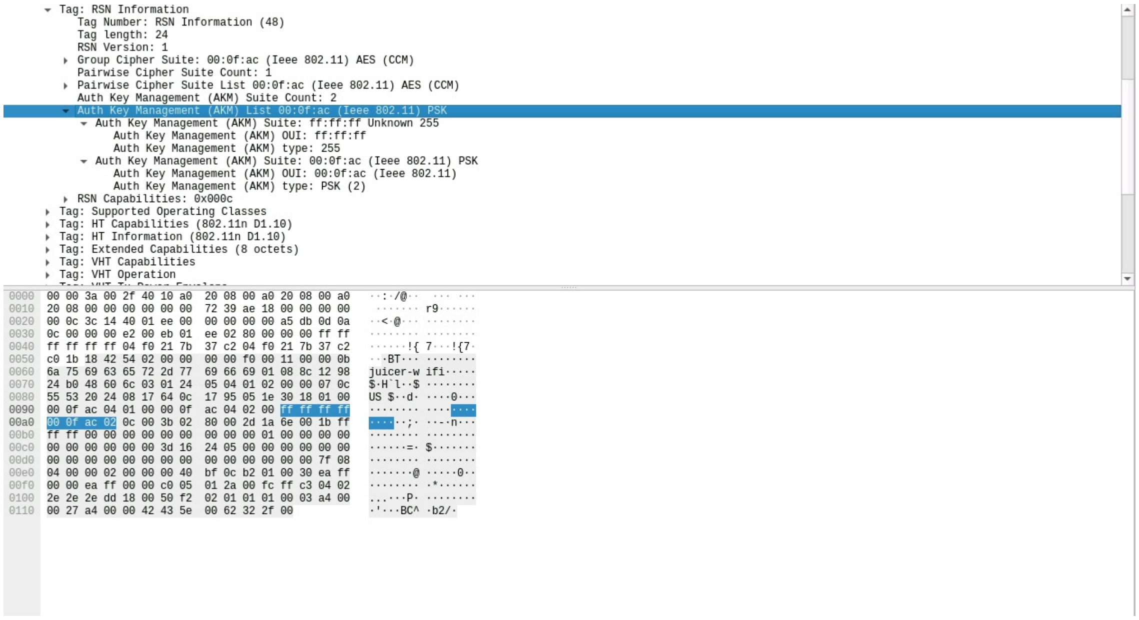
8. **Extra AKM suite (unsupported):**

   A. Configure **Custom WiFi** in `vap0000`:
   Select `vap0000` and click **Modify**.
   Navigate to the **Custom WiFi** tab.
   In the **User-Specified supplicant/hostapd configuration text** field, write:
   `own_ie_override=30180100000fac040100000fac040200ffffffff000fac020c00`.
   Click **Apply** then **OK**.

   B. Reset ports and sniff packets:
   Repeat steps B through D of Step 2.

   C. Observe the results, which should be similar to the following:
   - The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
   - RSN Information Element is present in Beacon frames sent by `vap0000`.
   - The RSN IE in a Beacon frame sent by `vap0000` contains two Pairwise Cipher Suite fields rather than one.
   - Beacon frames sent by `vap0000` are not malformed.

   D. Example results:



```
▾ Tag: RSN Information
     Tag Number: RSN Information (48)
     Tag length: 24
     RSN Version: 1
   ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
     Pairwise Cipher Suite Count: 1
   ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
     Auth Key Management (AKM) Suite Count: 2
   ▾ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
      ▾ Auth Key Management (AKM) Suite: ff:ff:ff Unknown 255
           Auth Key Management (AKM) OUI: ff:ff:ff
           Auth Key Management (AKM) type: 255
      ▾ Auth Key Management (AKM) Suite: 00:0f:ac (Ieee 802.11) PSK
           Auth Key Management (AKM) OUI: 00:0f:ac (Ieee 802.11)
           Auth Key Management (AKM) type: PSK (2)
   ▸ RSN Capabilities: 0x000c
▸ Tag: Supported Operating Classes
▸ Tag: HT Capabilities (802.11n D1.10)
▸ Tag: HT Information (802.11n D1.10)
▸ Tag: Extended Capabilities (8 octets)
▸ Tag: VHT Capabilities
▸ Tag: VHT Operation
▸ Tag: VHT Tx Power Envelope
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  72 39 ae 18 00 00 00 00    ········ r9······
0020  00 0c 3c 14 40 01 ee 00  00 00 00 00 a5 db 0d 0a   ··<·@··· ········
0030  0c 00 00 00 e2 00 eb 01  ee 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  c0 1b 18 42 54 02 00 00  00 00 f0 00 11 00 00 0b   ···BT··· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 01 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 18 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 02 00 ff ff ff ff   ········ ········
00a0  00 0f ac 02 0c 00 3b 02  80 00 2d 1a 6e 00 1b ff   ······;· ··-·n···
00b0  ff ff 00 00 00 00 00 00  00 00 00 01 00 00 00 00   ········ ········
00c0  00 00 00 00 00 00 3d 16  24 05 00 00 00 00 00 00   ······=· $·······
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 7f 08   ········ ········
00e0  04 00 00 02 00 00 00 40  bf 0c b2 01 00 30 ea ff   ·······@ ·····0··
00f0  00 00 ea ff 00 00 c0 05  01 2a 00 fc ff c3 04 02   ········ ·*······
0100  2e 2e 2e dd 18 00 50 f2  02 01 01 01 00 03 a4 00   ...···P· ········
0110  00 27 a4 00 00 42 43 5e  00 62 32 2f 00            ·'···BC^ ·b2/·
```

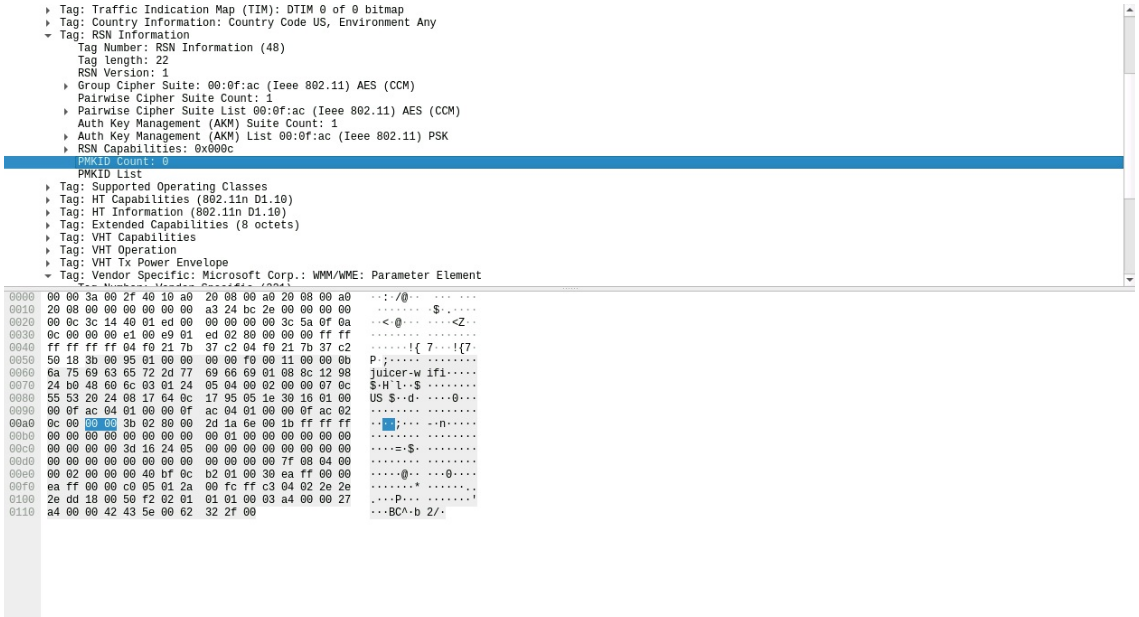
9. **PMKIDCount field included:**

   A. Configure **Custom WiFi** in `vap0000`:
   Select `vap0000` and click **Modify**.
   Navigate to the **Custom WiFi** tab.
   In the **User-Specified supplicant/hostapd configuration text** field, write:
   `own_ie_override=30160100000fac040100000fac040100000fac020c000000`.
   Click **Apply** then **OK**.

   B. Reset ports and sniff packets:
   Repeat steps B through D of Step 2.

   C. Observe the results, which should be similar to the following:
   - The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
   - RSN Information Element is present in Beacon frames sent by `vap0000`.
   - The RSN IE in a Beacon frame sent by `vap0000` contains a PMKIDCount field.
   - Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
▸ Tag: Traffic Indication Map (TIM): DTIM 0 of 0 bitmap
▸ Tag: Country Information: Country Code US, Environment Any
▾ Tag: RSN Information
    Tag Number: RSN Information (48)
    Tag length: 22
    RSN Version: 1
  ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
    Pairwise Cipher Suite Count: 1
  ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
    Auth Key Management (AKM) Suite Count: 1
  ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
  ▸ RSN Capabilities: 0x000c
    PMKID Count: 0
    PMKID List
▸ Tag: Supported Operating Classes
▸ Tag: HT Capabilities (802.11n D1.10)
▸ Tag: HT Information (802.11n D1.10)
▸ Tag: Extended Capabilities (8 octets)
▸ Tag: VHT Capabilities
▸ Tag: VHT Operation
▸ Tag: VHT Tx Power Envelope
▾ Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
    Tag Number: Vendor Specific (221)
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  a3 24 bc 2e 00 00 00 00    ········ ·$·.····
0020  00 0c 3c 14 40 01 ed 00  00 00 00 00 3c 5a 0f 0a   ··<·@···  ····<Z··
0030  0c 00 00 00 e1 00 e9 01  ed 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  50 18 3b 00 95 01 00 00  00 00 f0 00 11 00 00 0b   P·;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 00 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 16 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 01 00 00 0f ac 02   ········ ········
00a0  0c 00 00 00 3b 02 80 00  2d 1a 6e 00 1b ff ff ff   ····;··· -·n·····
00b0  00 00 00 00 00 00 00 00  00 01 00 00 00 00 00 00   ········ ········
00c0  00 00 00 00 3d 16 24 05  00 00 00 00 00 00 00 00   ····=·$· ········
00d0  00 00 00 00 00 00 00 00  00 00 00 00 7f 08 04 00   ········ ········
00e0  00 02 00 00 00 40 bf 0c  b2 01 00 30 ea ff 00 00   ·····@·· ···0····
00f0  ea ff 00 00 c0 05 01 2a  00 fc ff c3 04 02 2e 2e   ·······* ······..
0100  2e dd 18 00 50 f2 02 01  01 01 00 03 a4 00 00 27   .···P··· ·······'
0110  a4 00 00 42 43 5e 00 62  32 2f 00                  ···BC^·b 2/·
```

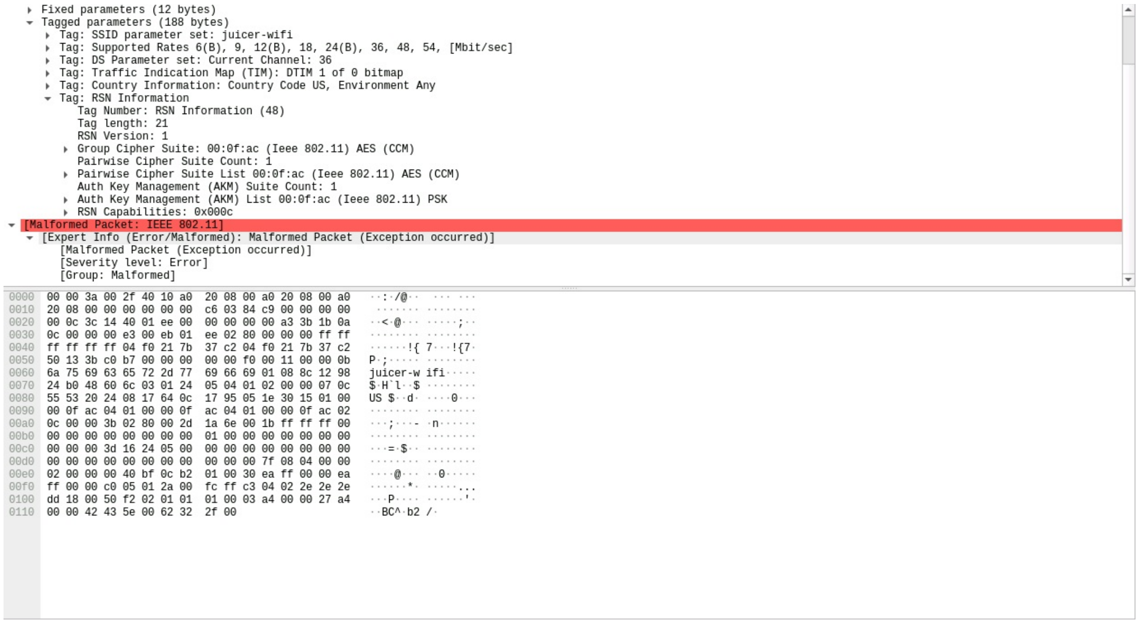
10. **Truncated PMKIDCount field:**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=30150100000fac040100000fac040100000fac020c0000`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- The RSN IE in a Beacon frame sent by `vap0000` is present, but incomplete.
- Beacon frames sent by `vap0000` are recognizably malformed.

D. Example results:



```
▸ Fixed parameters (12 bytes)
▾ Tagged parameters (188 bytes)
  ▸ Tag: SSID parameter set: juicer-wifi
  ▸ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
  ▸ Tag: DS Parameter set: Current Channel: 36
  ▸ Tag: Traffic Indication Map (TIM): DTIM 1 of 0 bitmap
  ▸ Tag: Country Information: Country Code US, Environment Any
  ▾ Tag: RSN Information
      Tag Number: RSN Information (48)
      Tag length: 21
      RSN Version: 1
    ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
      Pairwise Cipher Suite Count: 1
    ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
      Auth Key Management (AKM) Suite Count: 1
    ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
    ▸ RSN Capabilities: 0x000c
▾ [Malformed Packet: IEEE 802.11]
  ▾ [Expert Info (Error/Malformed): Malformed Packet (Exception occurred)]
      [Malformed Packet (Exception occurred)]
      [Severity level: Error]
      [Group: Malformed]
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  c6 03 84 c9 00 00 00 00    ········ ········
0020  00 0c 3c 14 40 01 ee 00  00 00 00 00 a3 3b 1b 0a   ··<·@···  ·····;··
0030  0c 00 00 00 e3 00 eb 01  ee 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  50 13 3b c0 b7 00 00 00  00 00 f0 00 11 00 00 0b   P·;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 01 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 15 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 01 00 00 0f ac 02   ········ ········
00a0  0c 00 00 3b 02 80 00 2d  1a 6e 00 1b ff ff ff 00   ···;···- ·n······
00b0  00 00 00 00 00 00 00 00  01 00 00 00 00 00 00 00   ········ ········
00c0  00 00 00 3d 16 24 05 00  00 00 00 00 00 00 00 00   ···=·$·· ········
00d0  00 00 00 00 00 00 00 00  00 00 00 7f 08 04 00 00   ········ ········
00e0  02 00 00 00 40 bf 0c b2  01 00 30 ea ff 00 00 ea   ····@··· ··0·····
00f0  ff 00 00 c0 05 01 2a 00  fc ff c3 04 02 2e 2e 2e   ······*· ·····...
0100  dd 18 00 50 f2 02 01 01  01 00 03 a4 00 00 27 a4   ···P···· ······'·
0110  00 00 42 43 5e 00 62 32  2f 00                     ··BC^·b2 /·
```

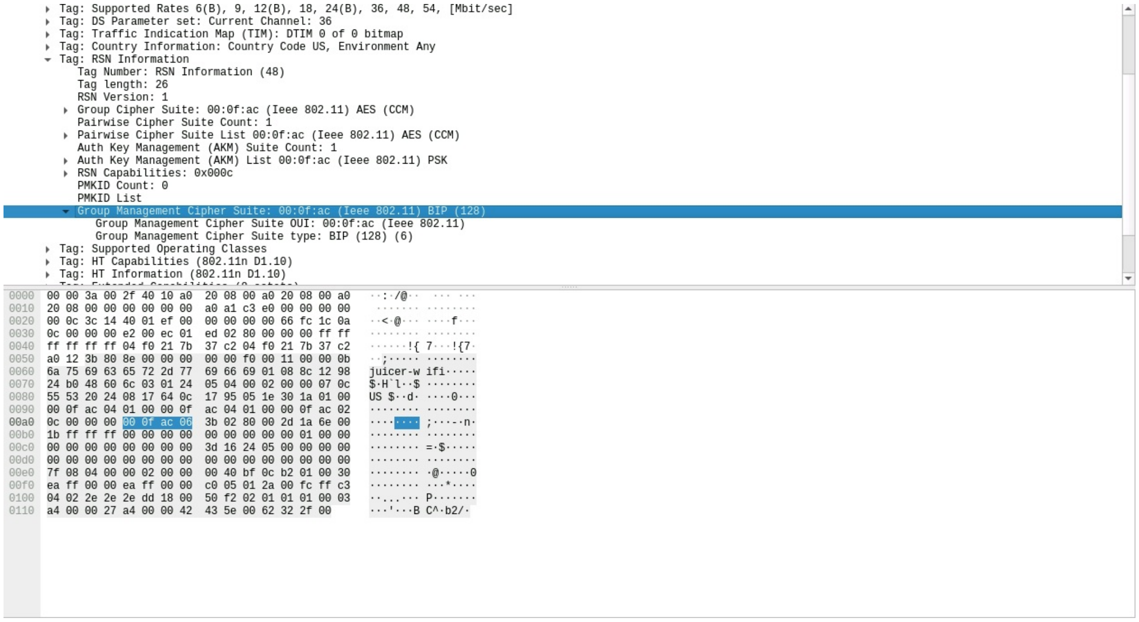
11. **Unexpected Group Management Cipher Suite with PMF disabled:**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=301a0100000fac040100000fac040100000fac020c000000000fac06`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- The RSN IE in a Beacon frame sent by `vap0000` contains a Group Management Cipher field.
- Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
▸ Tag: Supported Rates 6(B), 9, 12(B), 18, 24(B), 36, 48, 54, [Mbit/sec]
▸ Tag: DS Parameter set: Current Channel: 36
▸ Tag: Traffic Indication Map (TIM): DTIM 0 of 0 bitmap
▸ Tag: Country Information: Country Code US, Environment Any
▾ Tag: RSN Information
     Tag Number: RSN Information (48)
     Tag length: 26
     RSN Version: 1
   ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
     Pairwise Cipher Suite Count: 1
   ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
     Auth Key Management (AKM) Suite Count: 1
   ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
   ▸ RSN Capabilities: 0x000c
     PMKID Count: 0
     PMKID List
   ▾ Group Management Cipher Suite: 00:0f:ac (Ieee 802.11) BIP (128)
        Group Management Cipher Suite OUI: 00:0f:ac (Ieee 802.11)
        Group Management Cipher Suite type: BIP (128) (6)
▸ Tag: Supported Operating Classes
▸ Tag: HT Capabilities (802.11n D1.10)
▸ Tag: HT Information (802.11n D1.10)
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  a0 a1 c3 e0 00 00 00 00    ······· ········
0020  00 0c 3c 14 40 01 ef 00  00 00 00 00 66 fc 1c 0a   ··<·@··· ····f···
0030  0c 00 00 00 e2 00 ec 01  ed 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  a0 12 3b 80 8e 00 00 00  00 00 f0 00 11 00 00 0b   ··;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 00 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 1a 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 01 00 00 0f ac 02   ········ ········
00a0  0c 00 00 00 00 0f ac 06  3b 02 80 00 2d 1a 6e 00   ········ ;···-·n·
00b0  1b ff ff ff 00 00 00 00  00 00 00 00 00 01 00 00   ········ ········
00c0  00 00 00 00 00 00 00 00  3d 16 24 05 00 00 00 00   ········ =·$·····
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
00e0  7f 08 04 00 00 02 00 00  00 40 bf 0c b2 01 00 30   ········ ·@·····0
00f0  ea ff 00 00 ea ff 00 00  c0 05 01 2a 00 fc ff c3   ········ ···*····
0100  04 02 2e 2e 2e dd 18 00  50 f2 02 01 01 01 00 03   ··...··· P·······
0110  a4 00 00 27 a4 00 00 42  43 5e 00 62 32 2f 00      ···'···B C^·b2/·
```

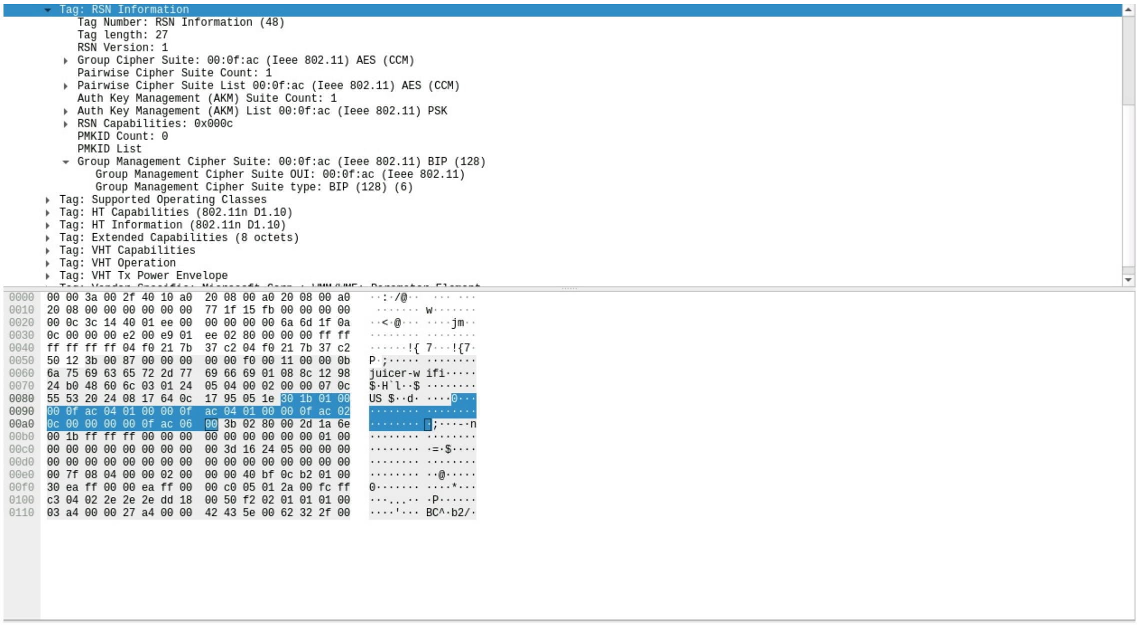
12. **Extra octet after defined fields (future extensibility):**

A. Configure **Custom WiFi** in `vap0000`:
Select `vap0000` and click **Modify**.
Navigate to the **Custom WiFi** tab.
In the **User-Specified supplicant/hostapd configuration text** field, write:
`own_ie_override=301b0100000fac040100000fac040100000fac020c000000000fac0600`.
Click **Apply** then **OK**.

B. Reset ports and sniff packets:
Repeat steps B through D of Step 2.

C. Observe the results, which should be similar to the following:
- The station `wlan1` fails to authenticate with `vap0000` with `CTRL-MSG: NETWORK NOT FOUND`.
- The RSN IE in a Beacon frame sent by `vap0000` contains a Group Management Cipher field.
- Beacon frames sent by `vap0000` are not malformed.

D. Example results:



```
    ▾ Tag: RSN Information
          Tag Number: RSN Information (48)
          Tag length: 27
          RSN Version: 1
        ▸ Group Cipher Suite: 00:0f:ac (Ieee 802.11) AES (CCM)
          Pairwise Cipher Suite Count: 1
        ▸ Pairwise Cipher Suite List 00:0f:ac (Ieee 802.11) AES (CCM)
          Auth Key Management (AKM) Suite Count: 1
        ▸ Auth Key Management (AKM) List 00:0f:ac (Ieee 802.11) PSK
        ▸ RSN Capabilities: 0x000c
          PMKID Count: 0
          PMKID List
        ▾ Group Management Cipher Suite: 00:0f:ac (Ieee 802.11) BIP (128)
              Group Management Cipher Suite OUI: 00:0f:ac (Ieee 802.11)
              Group Management Cipher Suite type: BIP (128) (6)
    ▸ Tag: Supported Operating Classes
    ▸ Tag: HT Capabilities (802.11n D1.10)
    ▸ Tag: HT Information (802.11n D1.10)
    ▸ Tag: Extended Capabilities (8 octets)
    ▸ Tag: VHT Capabilities
    ▸ Tag: VHT Operation
    ▸ Tag: VHT Tx Power Envelope
    ▸ Tag: Vendor Specific: Microsoft Corp.: WMM/WME: Parameter Element
```

```
0000  00 00 3a 00 2f 40 10 a0  20 08 00 a0 20 08 00 a0   ··:·/@··  ··· ···
0010  20 08 00 00 00 00 00 00  77 1f 15 fb 00 00 00 00    ······· w·······
0020  00 0c 3c 14 40 01 ee 00  00 00 00 00 6a 6d 1f 0a   ··<·@···  ····jm··
0030  0c 00 00 00 e2 00 e9 01  ee 02 80 00 00 00 ff ff   ········ ········
0040  ff ff ff ff 04 f0 21 7b  37 c2 04 f0 21 7b 37 c2   ······!{ 7···!{7·
0050  50 12 3b 00 87 00 00 00  00 00 f0 00 11 00 00 0b   P·;····· ········
0060  6a 75 69 63 65 72 2d 77  69 66 69 01 08 8c 12 98   juicer-w ifi·····
0070  24 b0 48 60 6c 03 01 24  05 04 00 02 00 00 07 0c   $·H`l··$ ········
0080  55 53 20 24 08 17 64 0c  17 95 05 1e 30 1b 01 00   US $··d· ····0···
0090  00 0f ac 04 01 00 00 0f  ac 04 01 00 00 0f ac 02   ········ ········
00a0  0c 00 00 00 00 0f ac 06  00 3b 02 80 00 2d 1a 6e   ········ ·;···-·n
00b0  00 1b ff ff ff 00 00 00  00 00 00 00 00 00 01 00   ········ ········
00c0  00 00 00 00 00 00 00 00  00 3d 16 24 05 00 00 00   ········ ·=·$····
00d0  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00   ········ ········
00e0  00 7f 08 04 00 00 02 00  00 00 40 bf 0c b2 01 00   ········ ··@·····
00f0  30 ea ff 00 00 ea ff 00  00 c0 05 01 2a 00 fc ff   0······· ····*···
0100  c3 04 02 2e 2e 2e dd 18  00 50 f2 02 01 01 01 00   ···...·· ·P······
0110  03 a4 00 00 27 a4 00 00  42 43 5e 00 62 32 2f 00   ····'··· BC^·b2/·
```