Using more of the features of Wireshark to Write Better Dissectors

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About me?

- Contributed to Wireshark since ~1999
  - Was called Ethereal then
- Do a lot of work with Wireless protocols now
- Wrote a bunch of early dissectors like SMB, FTP, etc.

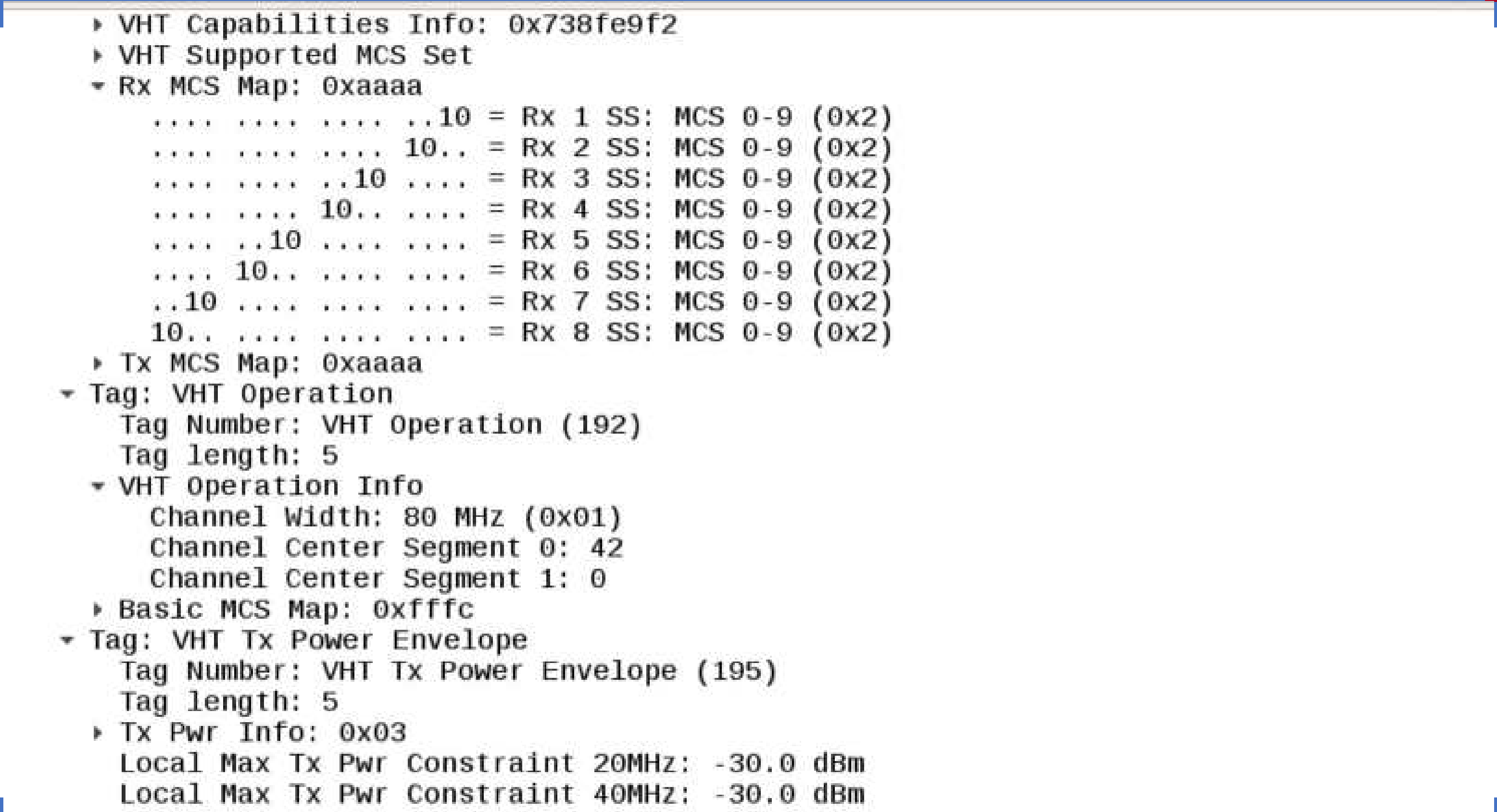
Agenda

- Dissector outline
- Converting values to meaning strings
- Adding units to displayed values
- Handling bit fields
- Custom display functions
- Dissector tables
- Expert information
- More...

General hints

- Lots of information in doc/README.dissector
  - Can be hard to find your way around
- Use other dissectors to get hints
- 'git grep'

An example



```
  ▸ VHT Capabilities Info: 0x738fe9f2
  ▸ VHT Supported MCS Set
  ▾ Rx MCS Map: 0xaaaa
      .... .... .... ..10 = Rx 1 SS: MCS 0-9 (0x2)
      .... .... .... 10.. = Rx 2 SS: MCS 0-9 (0x2)
      .... .... ..10 .... = Rx 3 SS: MCS 0-9 (0x2)
      .... .... 10.. .... = Rx 4 SS: MCS 0-9 (0x2)
      .... ..10 .... .... = Rx 5 SS: MCS 0-9 (0x2)
      .... 10.. .... .... = Rx 6 SS: MCS 0-9 (0x2)
      ..10 .... .... .... = Rx 7 SS: MCS 0-9 (0x2)
      10.. .... .... .... = Rx 8 SS: MCS 0-9 (0x2)
  ▸ Tx MCS Map: 0xaaaa
▾ Tag: VHT Operation
    Tag Number: VHT Operation (192)
    Tag length: 5
  ▾ VHT Operation Info
      Channel Width: 80 MHz (0x01)
      Channel Center Segment 0: 42
      Channel Center Segment 1: 0
  ▸ Basic MCS Map: 0xfffc
▾ Tag: VHT Tx Power Envelope
    Tag Number: VHT Tx Power Envelope (195)
    Tag length: 5
  ▸ Tx Pwr Info: 0x03
    Local Max Tx Pwr Constraint 20MHz: -30.0 dBm
    Local Max Tx Pwr Constraint 40MHz: -30.0 dBm
```

Dissector outline

- Definitions (hf and ett declarations)
- Any value_strings, true_false_strings
- The dissector function
- The header field registrations
- The ett value registrations

Dissector outline,cont

- You have a tvb (linear bag of bytes)
- You march along the tvb displaying fields
  - Bit fields, byte fields, 16-bit fields, 32-bit fields...
- Increment offset to indicate position in the tvb
- Insert sub-trees where you need them for grouping

Dissector outline, code

```
static int hf_ieee80211_tag_wnm_sleep_mode_action_type = -1;
. . .

static const value_string wnm_sleep_mode_action_types[] = {
  { 0, "Enter WNM-Sleep Mode" },
  { 1, "Exit WNM-Sleep Mode" },
  { 0, NULL }
};

static int
dissect_wnm_sleep_mode(tvbuff_t *tvb, packet_info *pinfo _U_, proto_tree *tree, void* data _U_)
{
  int offset = 0;
  proto_tree_add_item(tree, hf_ieee80211_tag_wnm_sleep_mode_action_type,
                      tvb, offset, 1, ENC_LITTLE_ENDIAN);
  offset++;
  proto_tree_add_item(tree, hf_ieee80211_tag_wnm_sleep_mode_response_status,
                      tvb, offset, 1, ENC_LITTLE_ENDIAN);
  offset++;
  proto_tree_add_item(tree, hf_ieee80211_tag_wnm_sleep_mode_interval,
                      tvb, offset, 2, ENC_LITTLE_ENDIAN);
  offset += 2;
  return offset;
}
. . .
    /* WNM-Sleep Mode */
    {&hf_ieee80211_tag_wnm_sleep_mode_action_type,
     {"Action Type", "wlan.wnm_sleep_mode.action_type",
      FT_UINT8, BASE_DEC, VALS(wnm_sleep_mode_action_types), 0,
      "WNM-Sleep Mode Action Type", HFILL }},
```

Dissector Outline, code

```
static int hf_ieee80211_tag_wnm_sleep_mode_action_type = -1;
. . .

static const value_string wnm_sleep_mode_action_types[] = {
  { 0, "Enter WNM-Sleep Mode" },
  { 1, "Exit WNM-Sleep Mode" },
  { 0, NULL }
};
```

Dissector Outline, code

```c
static int
dissect_wnm_sleep_mode(tvbuff_t *tvb, packet_info *pinfo _U_,
proto_tree *tree, void* data _U_)
{
  int offset = 0;
  proto_tree_add_item(tree, hf_tag_wnm_sleep_mode_action_type,
                      tvb, offset, 1, ENC_LITTLE_ENDIAN);
  offset++;
  proto_tree_add_item(tree, hf_tag_wnm_sleep_mode_response_status,
                      tvb, offset, 1, ENC_LITTLE_ENDIAN);
  offset++;
  proto_tree_add_item(tree, hf_tag_wnm_sleep_mode_interval,
                      tvb, offset, 2, ENC_LITTLE_ENDIAN);
  offset += 2;
  return offset;
}
```

Dissector Outline, code

```
/* WNM-Sleep Mode */
    {&hf_tag_wnm_sleep_mode_action_type,
     {"Action Type", "wlan.wnm_sleep_mode.action_type",
      FT_UINT8, BASE_DEC, VALS(wnm_sleep_mode_action_types), 0,
      "WNM-Sleep Mode Action Type", HFILL }},
```

Converting values to strings

- Define your value strings
- Refer to the value_string in a header field

```
static const value_string ff_vht_mimo_cntrl_channel_width_vals[] = {
  {0x00, "20 MHz"},
  {0x01, "40 MHz"},
  {0x02, "80 MHz"},
  {0x03, "160 MHz / 80+80 MHz"},
  {0, NULL}
};

. . . some code . . .

    {&hf_ieee80211_ff_vht_mimo_cntrl_channel_width,
     {"Channel Width", "wlan.vht.mimo_control.chanwidth",
      FT_UINT24, BASE_HEX, VALS(ff_vht_mimo_cntrl_channel_width_vals), 0x0000C0,
      NULL, HFILL }},
```

Values to strings, cont

- What if you have some unused values
  - Wireshark will display them as “unknown”
- What if the protocol requires “reserved”?
  - You have a couple of choices
- Define the reserved values
  - Not practical if a large number (> ~10)
- Use a range string
- Use a custom formatting field (later slide)

Values to strings, cont

- Range strings
  - A value range and a string

```
static const range_string some_ranges_vals[] = {
  {0, 0, "No Limit"},
  {1, 1, "4 Basic subframes"},
  {2, 2, "8 Basic subframes"},
  {3, 3, "16 Basic subframes"},
  {4, 4, "32 Basic subframes"},
  {5, 5, "64 Basic subframes"},
  {6, 6, "128 Basic subframes"},
  {7, 7, "256 Basic subframes"},
  {8, 255, "reserved"},
  {0, 0, NULL}
};
```

Adding units to values

- When you need to add units to a value
  - Use BASE_UNIT_STRING and specify the unit
  - There are many predefined in epan/unit_strings.h

```
{&hf_hs20_reauth_delay,
 {"Re-Auth Delay", "wlan.hs20.deauth.reauth_delay",
  FT_UINT16, BASE_DEC|BASE_UNIT_STRING, &units_seconds,
  0, NULL, HFILL }},
```

Handling bitfields

- Two ways
  - Write a series of proto_tree_add_item statements
    - One for each bitfield
    - Specifying the same offset each time
    - The hf fields control the bitmask used
  - Use proto_tree_add_bitmask
    - Or proto_tree_add_bitmask_with_flags

Handling bitfields, code 1

```
    mfb_subtree = proto_item_add_subtree(ti, ett_mfb_subtree);
    proto_tree_add_item(mfb_subtree, hf_ieee80211_htc_num_sts, tvb, offset, 4, ENC_LITTLE_ENDIAN);
    proto_tree_add_item(mfb_subtree, hf_ieee80211_htc_vht_mcs, tvb, offset, 4, ENC_LITTLE_ENDIAN);
    proto_tree_add_item(mfb_subtree, hf_ieee80211_htc_bw, tvb, offset, 4, ENC_LITTLE_ENDIAN);

. . .

    {&hf_ieee80211_htc_num_sts,
     {"NUM_STS", "wlan.htc.num_sts",
      FT_UINT32, BASE_DEC, NULL, 0x00000E00,
      "Recommended NUM_STS", HFILL }},

    {&hf_ieee80211_htc_vht_mcs,
     {"VHT-MCS", "wlan.htc.vht_mcs",
      FT_UINT32, BASE_DEC, NULL, 0x0000F000,
      "Recommended VHT-MCS", HFILL }},

    {&hf_ieee80211_htc_bw,
     {"BW", "wlan.htc.bw",
      FT_UINT32, BASE_DEC, VALS(ieee80211_htc_bw_recommended_vht_mcs_vals), 0x00030000,
      "Bandwidth for recommended VHT-MCS", HFILL }},
```

Handling bitfields, code 2

```
static const int *ieee80211_hta3[] = {
    &hf_ieee80211_hta_basic_stbc_mcs,
    &hf_ieee80211_hta_dual_stbc_protection,
    &hf_ieee80211_hta_secondary_beacon,
    &hf_ieee80211_hta_lsig_txop_protection,
    &hf_ieee80211_hta_pco_active,
    &hf_ieee80211_hta_pco_phase,
    NULL
};

. . .

  /* 2 byte HT additional capabilities */
  proto_tree_add_bitmask_with_flags(tree, tvb, offset, hf_ieee80211_hta_cap2,
                                    ett_hta_cap2_tree, ieee80211_hta3,
                                    ENC_LITTLE_ENDIAN, BMT_NO_APPEND);
  offset += 2;
```

Handling bitfields, code 3

```
{&hf_ieee80211_hta_cap2,
 {"HT Additional Capabilities", "wlan.hta.capabilities",
  FT_UINT16, BASE_HEX, NULL, 0,
  "HT Additional Capability information", HFILL }},

. . .

{&hf_ieee80211_hta_basic_stbc_mcs,
 {"Basic STB Modulation and Coding Scheme (MCS)",
   "wlan.hta.capabilities.basic_stbc_mcs",
  FT_UINT16, BASE_HEX, NULL , 0x007f,
  NULL, HFILL }},

. . .

{&hf_ieee80211_fc_to_ds,
 {"To DS", "wlan.fc.tods",
  FT_BOOLEAN, 8, TFS(&tods_flag), FLAG_TO_DS,
  "To DS flag", HFILL }},    /* 4 */
```

Custom display functions

- When you need precise control over how a field's value is displayed
  - Use a custom display function
  - Can perform many calculations
- Produces a better result than other techniques

Custom display, code 1

```
/*
 * Print the UL target RSSI field as per the spec.
 *  0->30 map to -90 to -30 dBm.
 *  31 maps to Max transmit power */
static void
ul_target_rssi_base_custom(gchar *result, guint32 target_rssi)
{
  if (target_rssi <= 30) {
    g_snprintf(result, ITEM_LABEL_LENGTH, "%ddBm", -90 + (2 *
target_rssi));
  } else if (target_rssi == 31) {
    g_snprintf(result, ITEM_LABEL_LENGTH, "Max transmit power");
  }
}


. . .

    {&hf_ieee80211_he_ul_target_rssi,
     {"UL Target RSSI", "wlan.htc.he.a_control.umrs.ul_target_rssi",
      FT_UINT8, BASE_CUSTOM, CF_FUNC(ul_target_rssi_base_custom), 0x0,
       NULL, HFILL }},
```

Custom Display, code 2

```
/*
 * Print the target RSSI field as per the spec.
 *  0->90 map to -110 to -20 dBm.
 *  127 maps to Max ransmit power for assigned MCS
 *  rest are reserved.
 */
static void
target_rssi_base_custom(gchar *result, guint32 target_rssi)
{
  if (target_rssi <= 90) {
    g_snprintf(result, ITEM_LABEL_LENGTH, "%ddBm", -110 + target_rssi);
  } else if (target_rssi == 127) {
    g_snprintf(result, ITEM_LABEL_LENGTH, "Max transmit power");
  } else {
    g_snprintf(result, ITEM_LABEL_LENGTH, "Reserved");
  }
}
```

Custom display alternative

- proto_tree_add_uint_format
  - Will need to get the value from the tvb
    - tvb_get_guint8 etc
  - Will need a series of if tests or a case statement
- Makes the code more cluttered

Dissector Tables

- When you need to make dissection functions available to other dissectors
  - You could simply make them non static and call them from the other function
  - Kind of ugly and frowned upon
- Use dissector tables
- A bit of work to do, however

Dissector Tables, code 1

- Register the dissector table

```
wifi_alliance_anqp_info_table =
         register_dissector_table("wlan.anqp.wifi_alliance.subtype",
                                  "Wi-Fi Alliance ANQP Subtype",
                                  proto_wlan, FT_UINT8, BASE_HEX);
```

Dissector Tables, code 2

- Add dissectors to it
  - In the proto_reg_handoff function

```
dissector_add_uint("wlan.anqp.wifi_alliance.subtype",
                   WFA_SUBTYPE_HS20_ANQP,
                   create_dissector_handle(dissect_hs20_anqp, -1));
dissector_add_uint("wlan.ie.wifi_alliance.subtype",
                   WFA_SUBTYPE_SUBSCRIPTION_REMEDIATION,
                   create_dissector_handle(dissect_hs20_subscription_remediation,
                   -1));
dissector_add_uint("wlan.ie.wifi_alliance.subtype",
                   WFA_SUBTYPE_DEAUTHENTICATION_IMMINENT,
                   create_dissector_handle(dissect_hs20_deauthentication_imminent,
                   -1));
```

Dissector Tables, code 3

- Call through the dissector table
- You cannot pass offset
  - Need to create a new tvb
  - You can pass a pointer to a blob of data
- If there is no dissector for subtype, returns 0

```
subtvb = tvb_new_subset_remaining(tvb, offset);
if (!dissector_try_uint_new(wifi_alliance_anqp_info_table, subtype,
                                 subtvb, pinfo, tree, FALSE, data))
      call_data_dissector(subtvb, pinfo, tree);
```

Dissector Tables, code 4

- What the dissector looks like

```
static int
dissect_hs20_anqp(tvbuff_t *tvb, packet_info *pinfo, proto_tree *tree,
                  void *data)
{
 . . .

    return tvb_captured_length(tvb); // How many bytes we consumed
}
```

Dissector Tables, code 5

- Finding a dissector table from another dissector
  - In the proto_reg_handoff function

```
media_type_dissector_table = find_dissector_table("media_type");
```

Expert information

- Adding expert information is relatively simple
  - Define ei variables similar to hf variable
  - Register your ei variables
  - Call expert_add_info or expert_add_info_format

Expert information, code 1

- Defining your ei variables

```
static expert_field ei_ieee80211_bad_length = EI_INIT;
static expert_field ei_ieee80211_inv_val = EI_INIT;
static expert_field ei_ieee80211_vht_tpe_pwr_info_count = EI_INIT;
static expert_field ei_ieee80211_ff_query_response_length = EI_INIT;
```

Expert information, code 2

- Registering your ei definitions
- A number of groups (PI_MALFORMED) available
  - PI_DEBUG, PI_MALFORMED, PI_PROTOCOL, etc
- A number of severities (PI_ERROR) available
  - PI_ERROR, PI_WARN, PI_NOTE, etc

```
{ &ei_ieee80211_bad_length,
  { "ieee80211.bad_length", PI_MALFORMED, PI_ERROR,
    "Wrong length indicated", EXPFILL }},
```

Expert information, code 3

- Two functions you can call
  - expert_add_info
  - expert_add_info_format

```
expert_add_info(pinfo, tix, &ei_ieee80211_tag_measure_report_unknown);

. . .

expert_add_info_format(pinfo, cw_item, &ei_ieee80211_dmg_subtype,
                       "DMG STA shouldn't transmit Control Wrapper frame");
```

A neat approach

```
{
        gint err = -1;
        int offset = some_value; // Usually from above us
        Int size = some_size_value;

        offset += 3;
        do {
                if (size < 1) break;
                proto_tree_add_item(tlv_root, hf_nan_attr_dialog_token,
                        tvb, offset, 1, ENC_NA);
                size -= 1; offset += 1;

                if (size < 1) break;
                . . .

                if (size == 0)
                        Err = 0;
        } while (0);
```

A neat approach, 2

```
if (err) {
        expert_add_info_format(pinfo, tlv_item,
                &ei_wifi_nan_attr_len, "Error parsing attribute");
}
```

The End

- Questions
- Feedback