

s110_nrf51822 migration document

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Introduction to the s110_nrf51822 migration document

About the document

This document describes how to migrate to new versions of the s110_nrf51822. The s110_nrf51822 release notes should be read in conjunction with this document.

There is one main section for each new version of the s110_nrf51822. Within each main section,

- "Required changes" describes how an application would have used the previous version of the SoftDevice, and how it must now use this version for the given change.
- "New functionality" describes how to use new features and functionality offered by this version of the SoftDevice. Note: Not all new functionality may be covered; the release notes will contain a full list of new features and functionality.

How to use the document

Each section describes how to migrate to a given version from the previous version. If you are migrating to the current version from the previous version, follow the instructions in that section.

To migrate between versions that are more than one version apart, follow the migration steps for all intermediate versions in order.

Example: To migrate from version 5.0.0 to version 5.2.0, first follow the instructions to migrate to 5.1.0 from 5.0.0, then follow the instructions to migrate to 5.2.0 from 5.1.0.

s110_nrf51822_7.0.0

This section describes how to migrate to s110_nrf51822_7.0.0 from s110_nrf51822_6.0.0.

Required changes

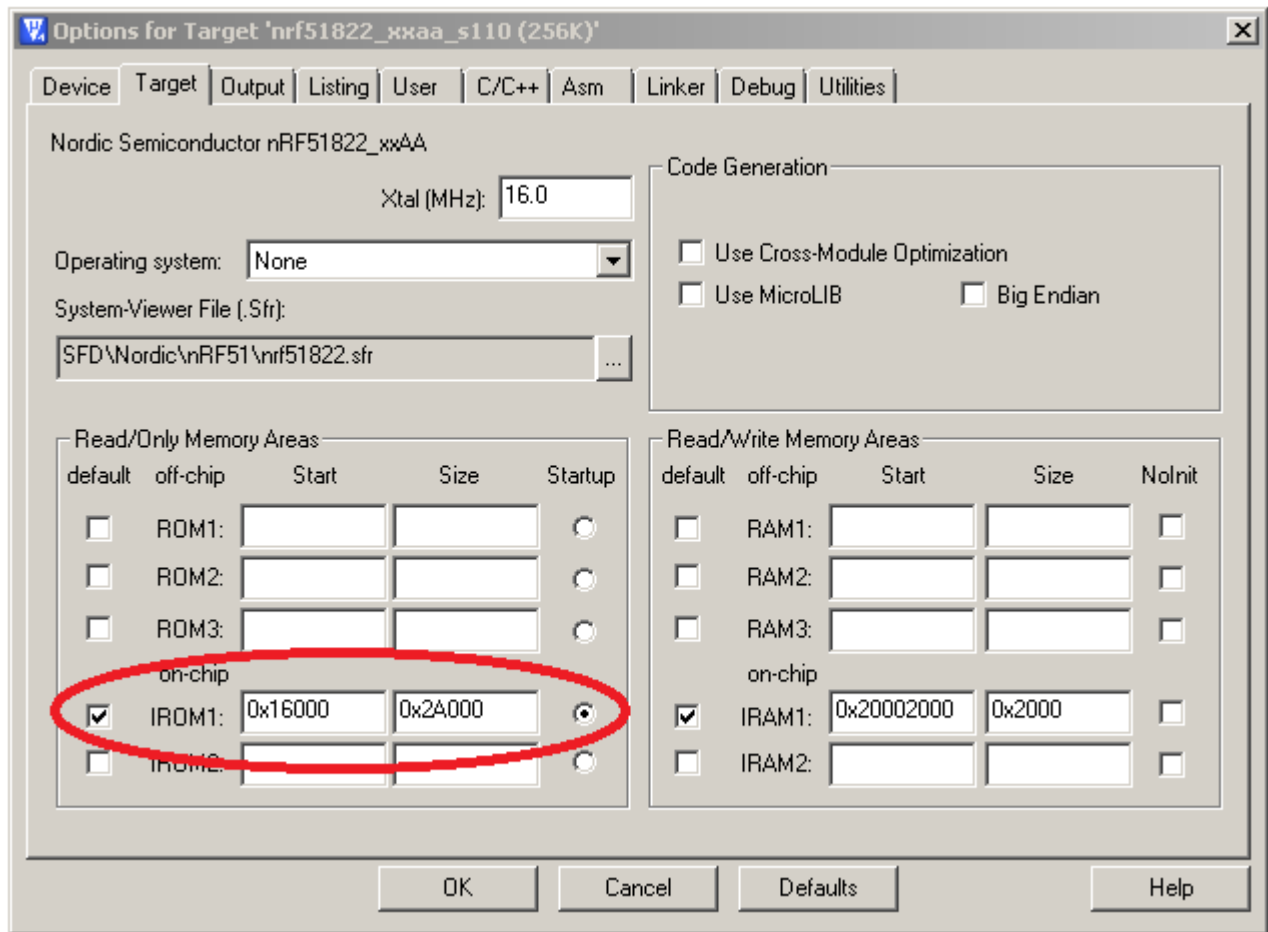
SoftDevice size

The size of the SoftDevice has changed requiring a change to the application project file.

For Keil this means:

- Go into the properties of the project and find the Target tab
- Change IROM1 Start to 0x16000
- Ensure that the IROM1 size is no more than 0x2A000

If the project uses a scatter file instead of the settings from the Target tab, the scatter file must be updated accordingly.



SVC number changes

The SVC numbers in use by the stack have been changed so the application needs to be recompiled against the new header files.

An additional call has to be made after `sd_softdevice_enable()` before any BLE related functionality in the SoftDevice can be used:

- `sd_ble_enable(p_ble_enable_params)`

Using this call, the application can select whether to include the Service Changed characteristic in the GATT Server. The default in all previous releases has been to include the Service Changed characteristic, but this affects how GATT clients behave. Specifically, it requires clients to subscribe to this attribute and not to cache attribute handles between connections unless the devices are bonded. If the application does not need to change the structure of the GATT server attributes at runtime this adds unnecessary complexity to the interaction with peer clients. If the SoftDevice is enabled with the Service Changed Characteristics turned off, then clients are allowed to cache attribute handles making applications simpler on both sides. Please see the SoftDevice API documentation for details.

Due to an issue present in this release, the application is required to set the device address to the factory default right after calling `sd_ble_enable()`, this can be achieved with the following lines:

```
sd_ble_gap_enable(p_ble_enable_params);
sd_ble_gap_address_get(&addr);
sd_ble_gap_address_set(BLE_GAP_ADDR_CYCLE_MODE_NONE, &addr);
```

`sd_ble_gap_address_set()` now takes an additional argument which is used to describe the private address cycle mode:

- `BLE_GAP_ADDR_CYCLE_MODE_NONE`
- `BLE_GAP_ADDR_CYCLE_MODE_AUTO`

To set all types of device addresses explicitly as with earlier versions of the SoftDevice, use

- `sd_ble_gap_address_set(BLE_GAP_ADDR_CYCLE_MODE_NONE, p_addr)`

To let the SoftDevice automatically cycle private addresses as defined by Bluetooth Core specification 4.1, use

- `sd_ble_gap_address_set(BLE_GAP_ADDR_CYCLE_MODE_AUTO, p_addr)`

where `p_addr->addr_type` is either `BLE_GAP_ADDR_TYPE_RANDOM_PRIVATE_RESOLVABLE` or `BLE_GAP_ADDR_TYPE_RANDOM_PRIVATE_NON_RESOLVABLE`.

Redirecting interrupts to an application from a bootloader has changed:

- `sd_softdevice_forward_to_application()` has been replaced with `sd_softdevice_vector_table_base_set(address)`

Interrupts can now be directed to anywhere in the application flash area. This also enables using more than one application. See the SoftDevice API documentation for details on how to use this call.

New functionality

The SoftDevice hex file no longer contains the SoftDevice size in the `UICR.CLENRO` register.

This means that the Memory Protection Unit is no longer configured to protect the SoftDevice code, memory space and protected peripherals, unless this is deliberately enabled. Memory protection must be disabled to allow Device Firmware Upgrade of the SoftDevice. However it may be useful to have the protection enabled during development to ease the detection of illegal memory and peripheral accesses.

- If the SoftDevice is programmed with nRFgo Studio 1.17 or newer, use the checkbox "Enable SoftDevice protection" in the "Program SoftDevice" dialog to enable or disable the protection.
- If the SoftDevice is programmed with `nrfjprog.exe` version 5.1.1 or newer using the `--programs` option, then protection is enabled.

- If the SoftDevice is programmed with nrfjprog.exe version 5.1.1 or newer using the --programs --dfu options, then protection is disabled.

The SoftDevice now includes a new Options API to allow the application to set and get advanced configuration options:

- `sd_ble_opt_get()`
- `sd_ble_opt_set()`

Three options are defined in this version of the SoftDevice:

- `BLE_GAP_OPT_LOCAL_CONN_LATENCY` can be used to override the Connection Latency specified by the Central.
- `BLE_GAP_OPT_PASSKEY` can be used to specify a 6-digit display passkey that will be used during pairing instead of a randomly generated one.
- `BLE_GAP_OPT_PRIVACY` can be used to tune the behaviour of the SoftDevice when advertising with private addresses.

Please see the SoftDevice API documentation for details on how to use the Options API.

The SoftDevice now has built-in support for more Advertising Data types.

Please see `ble_gap.h` for the full list of supported Advertising data types.

The SoftDevice now includes a Master Boot Record API, which can be used to switch between bootloaders and applications, and also to replace the bootloader(s) and/or the SoftDevice itself.

- `sd_mbr_command(command)`

Five commands are available in this release:

- `SD_MBR_COMMAND_COPY_BL` to copy a new bootloader into place.
- `SD_MBR_COMMAND_COPY_SD` to copy a new SoftDevice into place.
- `SD_MBR_COMMAND_INIT_SD` to initialize the SoftDevice from a bootloader and start forwarding interrupts to it.
- `SD_MBR_COMMAND_COMPARE` to compare flash memory blocks.
- `SD_MBR_COMMAND_VECTOR_TABLE_BASE_SET` to set the address to which interrupts are forwarded.

Please see the SoftDevice API documentation for details on how to use this call.

New LFCLK oscillator sources are available.

- `NRF_CLOCK_LFCLKSRC_RC_250_PPM_TEMP_1000MS_CALIBRATION`
- `NRF_CLOCK_LFCLKSRC_RC_250_PPM_TEMP_2000MS_CALIBRATION`
- `NRF_CLOCK_LFCLKSRC_RC_250_PPM_TEMP_4000MS_CALIBRATION`
- `NRF_CLOCK_LFCLKSRC_RC_250_PPM_TEMP_8000MS_CALIBRATION`
- `NRF_CLOCK_LFCLKSRC_RC_250_PPM_TEMP_16000MS_CALIBRATION`

These will all use the on-chip RC oscillator to generate a 250 PPM clock signal, but will save power by only calibrating it at the specified interval if the temperature has changed.

A new Concurrent Multiprotocol Timeslot API has been introduced.

This enables the application to schedule timeslots during which the SoftDevice gives the application control over the RADIO and TIMER0 hardware peripherals. This feature can be used to implement a separate radio protocol in application space that can run concurrently with the SoftDevice protocol, or to schedule timeslots where the SoftDevice is guaranteed to be idle, for example to improve latency for the application, or to reduce peak power consumption.

Three new API calls have been introduced:

- `sd_radio_session_open()`
- `sd_radio_session_close()`
- `sd_radio_request()`

Five new SoC Events have been introduced:

- `NRF_EVT_RADIO_BLOCKED`
- `NRF_EVT_RADIO_CANCELED`
- `NRF_EVT_RADIO_SIGNAL_CALLBACK_INVALID_RETURN`
- `NRF_EVT_RADIO_SESSION_IDLE`
- `NRF_EVT_RADIO_SESSION_CLOSED`

Please see the SoftDevice Specification document and the SoftDevice API documentation for details and guidelines on how to use this feature.

s110_nrf51822_6.0.0

This section describes how to migrate to s110_nrf51822_6.0.0 from s110_nrf51822_5.2.0 or s110_nrf51822_5.2.1.

Required changes

The following types and definitions have been renamed:

- `SD_EVENT_IRQn` is now `SD_EVT_IRQn`
- `SD_EVENT_IRQHandler` is now `SD_EVT_IRQHandler`
- `SD_APP_EVENT_WAIT` is now `SD_APP_EVT_WAIT`
- `SD_EVENT_GET` is now `SD_EVT_GET`
- `NRF_SOC_EVENTS` is now `NRF_SOC_EVTs`
- `NRF_EVENT_HFCLKSTARTED` is now `NRF_EVT_HFCLKSTARTED`
- `NRF_EVENT_POWER_FAILURE_WARNING` is now `NRF_EVT_POWER_FAILURE_WARNING`
- `NRF_EVENT_NUMBER_OF_EVENTS` is now `NRF_EVT_NUMBER_OF_EVENTS`
- `sd_app_event_wait()` is now `sd_app_evt_wait()`
- `sd_event_get()` is now `sd_evt_get()`

The SoC framework must now be used to obtain temperature readings:

- `sd_temp_get()`

The application may no longer access the `NRF_TEMP` registers directly when the SoftDevice is enabled.

The SoC framework now presents an API to access flash memory safely during active BLE connections:

- `sd_flash_write()`
- `sd_flash_page_erase()`
- `sd_flash_protect()`

The application may no longer perform flash memory write, erase or protect operations directly using `NRF_NVMC` and `NRF_MPU->PROTENSET` registers when the SoftDevice is enabled.

Two new events required for GATTS Queued Writes have been added to the API and need to be handled by the application:

- `BLE_EVT_USER_MEM_REQUEST`
- `BLE_EVT_USER_MEM_RELEASE`

Those events will only be issued by the SoftDevice whenever a Write Long Characteristic Value (or Descriptor) or a Reliable Write procedure is started by the peer GATT client. Details on how to handle those events can be found in the Message Sequence Charts included with the SoftDevice documentation, including indications to making use of the new API function:

- `sd_ble_user_mem_reply(USER_MEMORY)`

If the application does not wish to allow any of the aforementioned procedures to be executed (as in previous versions of the SoftDevice), a NULL pointer should be passed into the SoftDevice upon reception of the `BLE_EVT_USER_MEM_REQUEST` event, using the new API call:

- `sd_ble_user_mem_reply(NULL)`

By passing in a NULL pointer the application has provided no memory and therefore prevents the execution of the procedures, so that subsequent `BLE_GATTS_EVT_WRITE` or `BLE_GATTS_EVT_RW_AUTHORIZE_REQUEST` with the `op` field set to one of the new values (`BLE_GATTS_OP_PREP_WRITE_REQ`, `BLE_GATTS_OP_EXEC_WRITE_REQ_CANCEL` or `BLE_GATTS_OP_EXEC_WRITE_REQ_NOW`) can be safely ignored or denied respectively.

The following definition has been removed from the header files, since it is no longer required:

- `BLE_GAP_DEVNAME_MAX_WR_LEN`

Use this instead

- `BLE_GAP_DEVNAME_MAX_LEN`

The following structure member has been removed:

- `ble_gap_evt_disconnected_t.peer_addr`

New functionality

The following structure member has been added to allow the application to obtain the handle provided by the peer in an ATT Error Response:

- `ble_gattc_evt_t.error_handle`

Along with the support for GATTS Write Long and Reliable Write procedures, 3 new GATTS operation types have been added:

- `BLE_GATTS_OP_PREP_WRITE_REQ`
- `BLE_GATTS_OP_EXEC_WRITE_REQ_CANCEL`
- `BLE_GATTS_OP_EXEC_WRITE_REQ_NOW`

And 2 new GATT operation types and flags for GATTC Write Long and Reliable Write support:

- `BLE_GATT_OP_PREP_WRITE_REQ`
- `BLE_GATT_OP_EXEC_WRITE_REQ`
- `BLE_GATT_EXEC_WRITE_FLAG_PREPARED_CANCEL`
- `BLE_GATT_EXEC_WRITE_FLAG_PREPARED_WRITE`

The following structure member has been added for GATTC Execute Write Requests:

- `ble_gattc_write_params_t.flags`

The following structure member has been added for GATTC Prepare Write Response:

- `ble_gattc_evt_write_rsp_t.offset`

The following 2 functions now return the complete length of their respective arrays:

- `sd_ble_gap_device_name_get`
- `sd_ble_gatts_value_get`

In practical terms what this means is that the application is able to detect that the device name or the value of a certain attribute will not fit in the buffer it has provided to the SoftDevice:

Device name is currently: "Nordic Semiconductor" (20 bytes)

```
uint8_t buffer[10];
uint16_t len = sizeof(buffer);
uint32_t errcode;
errcode = sd_ble_gap_device_name_get(buffer, &len);
```

Here the output would be:

```
errcode = NRF_SUCCESS
len = 20
buffer = "Nordic Sem"
```

Additionally, the application can pass NULL as `p_dev_name` or `p_value` to obtain the full length.

The maximum number of 128-bit Vendor Specific UUIDs has been increased from 5 to 10, and is now exposed to the application:

- `BLE_UUID_VS_MAX_COUNT`

s110_nrf51822_5.2.0

This section describes how to migrate to s110_nrf51822_5.2.0 from s110_nrf51822_5.1.0.

Required changes

Due to changes in SoftDevice API header files, applications may need to include `nrf51_bitfields.h` and/or `nrf51_deprecated.h` explicitly.

s110_nrf51822_5.1.0

This section describes how to migrate to s110_nrf51822_5.1.0 from s110_nrf51822_5.0.0.

Required changes

No changes are required due to this upgrade.

Note: The `nrf_power_dcdc_mode*` API will be deprecated in a future version. See the "Limitations" section in the release notes for further information.

New functionality

No new functionality in this version.

s110_nrf51822_5.0.0

This section describes how to migrate to s110_nrf51822_5.0.0 from s110_nrf51822_4.0.0.

Required changes

Lower stack (Link Layer) interrupts are extended by a “CPU Suspend” state during radio activity to improve link integrity. This means lower stack interrupts will **block application and upper stack (Host) processing during a Radio Event** for a time proportional to the number of packets transferred in the event. The application's interrupt latency (both for App High and App Low interrupts) will therefore also increase by a time proportional to the number of packets transferred in the event due to the lower stack preventing the execution of lower priority contexts. Applications relying on low latency interrupts while the radio is active will therefore have to adapt to avoid timing issues.

The impact of this change and the required modifications to the application will highly depend on the application's nature, requirements and behavior. However, in general terms the application should refer to Table 10 (S110 interrupt latency lower stack) in the S110 SoftDevice Specification v1.1 to analyze how radio traffic will impact interrupt latency and incorporate the numbers in the design and implementation of the application's interrupt handlers.

A typical example of the timing potentially being off is using a TIMER or RTC peripheral running with a period shorter than the interrupt latencies described in the table above. Such short period configurations may cause the Interrupt Service Routine to miss ticks if the implementation keeps time by counting on its execution at a fixed frequency. A different timekeeping strategy needs to be used in this case, such as increasing the period (lowering the frequency) or accounting for missed Interrupt Service Routine execution instances by using the relevant information in registers provided by those peripherals.

The following **GATT Characteristic Presentation Format and Namespace definitions**:

- `BLE_GATT_CPF_FORMAT_*`
- `BLE_GATT_CPF_NAMESPACE_*`

have been moved from `ble_types.h` to `ble_gatt.h`.

Two additional definitions have been added to `ble_gatts.h`:

- `BLE_GATTS_FIX_ATTR_LEN_MAX`
- `BLE_GATTS_VAR_ATTR_LEN_MAX`

These macros define the maximum attribute value length for fixed and variable length attributes respectively.

s110_nrf51822_4.0.0

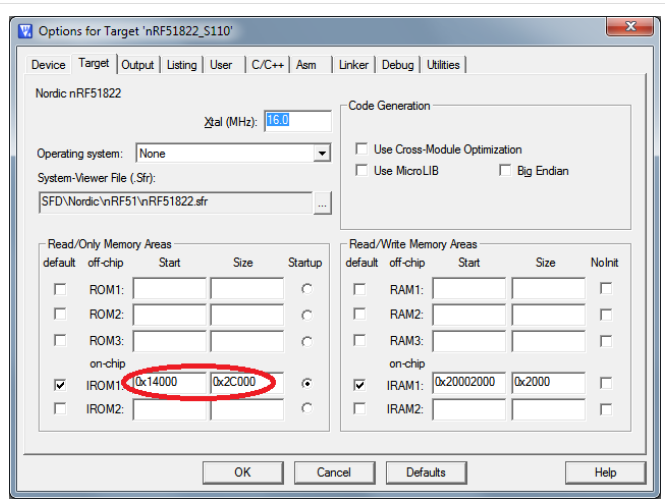
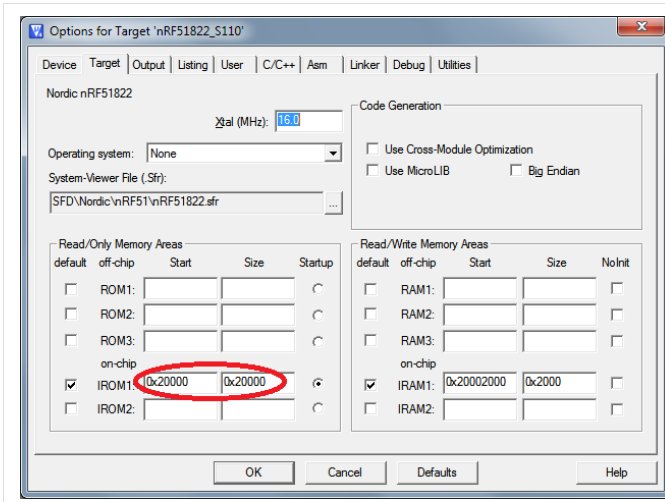
This section describes how to migrate to s110_nrf51822_4.0.0 from s110_nrf51822_3.0.0

Required changes

The flash requirements for the S110 SoftDevice have changed from 128kB to 80kB as of this version. All future releases of the **S110** SoftDevice will require 80kB of flash memory (i.e. `CODE_R1_BASE = 0x00014000`). To adapt to this new size, applications will need to redefine their base addresses from ~~`0x00020000`~~ to `0x00014000`.

In Keil, you can achieve this by changing the IROM1 value in the target options:

From:	To:
-------	-----



All SuperVisor Calls have been renamed in the 4.0.0 SoftDevice according to the following rules:

- nrf_* calls are now sd_*
- ble_* calls are now sd_ble_*
- SVC_* SVC IDs are now SD_*

Application source files that invoke SuperVisor Calls will have to be modified accordingly to match the new naming convention. When debugging an application the presence of an "sd_" prefix now signals the jump to a SoftDevice function in the form of an SVC.

The `sd_power_pof_enable()` function no longer uses a callback. Instead, use `sd_power_pof_enable(true)` to enable power failure detection; the `NRF_EVENT_POWER_FAILURE_WARNING` event will be returned by `sd_event_get()` if a power failure occurs.

UUID conversion functions are now in the SoftDevice. All UUIDs are represented in the S110 SoftDevice as a structure named `ble_uuid_t` containing 2 fields (`uuid` and `type`). This representation achieves better speed and memory efficiency than standard 2 and 16 byte arrays and makes it easier to interface with APIs using a unified UUID type. Starting from 4.0.0, the encoding and decoding functions are now inside the BLE stack instead of being in the SDK, and the table population function has changed. To be able to use the new functionality, the application will have to first add all the required 128-bit UUIDs so that they can be referenced later by the `ble_uuid_t` instances, calling the population function as many times as necessary.

This used to be achieved with the `ble_uuid_vs_assign()` function, which has now been removed in favor of `sd_ble_uuid_vs_add()`:

```
const ble_uuid128_t vs_uuids[] = {{0x11, 0x22, 0x33, 0x44, 0x55, 0x66, 0x77, 0x88, 0x99, 0xAA, 0xBB, 0xCC, 0x00, 0x00, 0xFF, 0x17},
{0xA1, 0xB2, 0xC3, 0xD4, 0xE5, 0xF6, 0x07, 0x18, 0x29, 0x3A, 0x4B, 0x5C, 0x00, 0x00, 0x6F, 0x77}};
```

```
uint8_t type;
uint32_t i, errcode;
```

```
errcode = ble_uuid_base_set(NUMELTS(vs_uuids), vs_uuids);
```

or

```
errcode = ble_uuid_vs_assign(NUMELTS(vs_uuids), vs_uuids);
```

```
for(i = 0; i < NUMELTS(vs_uuids); i++)
{
    errcode = sd_ble_uuid_vs_add((ble_uuid128_t const *) &vs_uuids[i], &type);
    ASSERT(errcode == NRF_SUCCESS);
    ASSERT(type == BLE_UUID_TYPE_VENDOR_BEGIN + i);
}
```

Later the code can call the encoding and decoding functions to convert 16 or 128-bit UUIDs into or from `ble_uuid_t` structures:

```
const ble_uuid128_t raw_sig_uuid = {0xFB, 0x34, 0x9B, 0x5F, 0x80, 0x00, 0x00, 0x80, 0x00, 0x10, 0x00, 0x00, 0x08, 0x82, 0x00, 0x00};
const ble_uuid128_t raw_vs_uuid = {0x11, 0x22, 0x33, 0x44, 0x55, 0x66, 0x77, 0x88, 0x99, 0xAA, 0xBB, 0xCC, 0x34, 0x12, 0xFF, 0x17};
```

```
uint8_t raw_output[16];
ble_uuid_t ble_uuid;
uint8_t uuid_len;
```

```
errcode = ble_uuid_decode(16, raw_sig_uuid.uuid128, &ble_uuid);
errcode = sd_ble_uuid_decode(16, raw_sig_uuid.uuid128, &ble_uuid);
```

```
errcode = ble_uuid_encode(&ble_uuid, &uuid_len, raw_output);
errcode = sd_ble_uuid_encode(&ble_uuid, &uuid_len, raw_output);
```

```

errcode = ble_uuid_decode(16, raw_vs_uuid.uuid128, &ble_uuid);
errcode = sd_ble_uuid_decode(16, raw_vs_uuid.uuid128, &ble_uuid);

errcode = ble_uuid_encode(&ble_uuid, &uuid_len, raw_output);
errcode = sd_ble_uuid_encode(&ble_uuid, &uuid_len, raw_output);

```

Applications can now check directly for characteristic properties in the corresponding bitfield included in the characteristic discovery response:

```

ble_evt_t ble_evt;

if((ble_evt.evt.gattc_evt.params.char_disc_rsp.chars[0].properties & 0x4)
&& (ble_evt.evt.gattc_evt.params.char_disc_rsp.chars[0].properties & 0x10))
{...}

if(ble_evt.evt.gattc_evt.params.char_disc_rsp.chars[0].char_props.write_wo_resp
&& ble_evt.evt.gattc_evt.params.char_disc_rsp.chars[0].char_props.notify)
{...}

```

The characteristic properties types are now shared between client and server and so GATTS service population has changed slightly:

```

ble_gatts_char_md_t char_md;

char_md.char_properties.notify = 1;
char_md.char_properties.broadcast = 1;
char_md.char_properties.wr_aux = 1;

char_md.char_props.notify = 1;
char_md.char_props.broadcast = 1;
char_md.char_ext_props.wr_aux = 1;

```

New functionality

It is now possible to clear the advertising data and/or the scan response data, and the combinations stand today as shown below:

```

sd_ble_gap_adv_data_set(uint8_t const * const p_data, uint8_t dlen, uint8_t const * const p_sr_data,
uint8_t srdlen);

p_data == NULL && dlen == 0      /* adv data unchanged */
p_sr_data == NULL && srdlen == 0 /* scan response data unchanged */
p_data != NULL && dlen == 0      /* adv data cleared (0-length packet) */
p_sr_data != NULL && srdlen == 0 /* scan response data cleared (0-length packet) */

```