s140_nrf52 release notes

Introduction to the s140_nrf52 release notes

These release notes describe the changes in the s140_nrf52 from version to version.

The release notes are intended to list all relevant changes in a given version. They are kept brief to make it easy to get an overview of the changes. More details regarding changes and new features may be found in the s140_nrf52 migration document (normally available for major releases only).

Issue numbers in parentheses are for internal use, and should be disregarded by the customer.

s140_nrf52_6.0.0

s140_nrf52_6.0.0 is the first SoftDevice production release for nRF52840. The main new features of this version compared to the s140_nrf52840_6.0.0-6.alpha are the Master Boot Record (MBR) 2.3, LE Coded PHY with S=2 coding support for connections, and Quality of Service (QoS) information.

Notes:

- This release has changed the Application Programmer Interface (API). This requires applications to be recompiled.
- The memory requirements of the S140 SoftDevice have changed.
- The release notes list changes since s140_nrf52840_6.0.0-6.alpha.
- LE Advertising Extensions and LE Long Range (LE Coded PHY) features are not Bluetooth Qualified in this production release. These features are suitable for development purposes but cannot be used in end products. These features are limited in functionality, may not function as specified, and may contain issues. The Qualified Design Identifier (QDID) for S140 will not include qualification of these features. In future releases of this SoftDevice, LE Advertising Extensions and LE Long Range (LE Coded PHY) will be fully qualified. At that time, a new QDID will be available which includes these features for new product listings.
- s140_nrf52_6.0.0 contains Errata workarounds that are adapted for the prototype version of the nRF52840 (revision A). The latest version compatible with nRF52840 revision A Errata was s140_nrf52840_6.0.0-6.alpha. s140_nrf52_6.0.0 should be used with nRF52840 revision B or later for production or performance measurements.
- The SoftDevice release naming convention has changed: Instead of specifying the platform supported by the SoftDevice in the release name, the release notes will have this information.

SoftDevice properties

- This SoftDevice variant is production tested for nRF52840.
- This version of the SoftDevice contains the Master Boot Record (MBR) version 2.3.0 (DRGN-9755).
  - It is possible to perform Device Firmware Upgrade from earlier s140 alpha (with mbr_nrf52_2.3.0-x.alpha) releases to s140_nrf52_6.0.0 for development purposes.
  - MBR 2.3.0 should be used in all production devices.
- The combined MBR and SoftDevice memory requirements for this version are as follows:
  - Flash: **152 kB** (0x26000 bytes).
  - RAM: **5.54 kB** (0x1628 bytes). This is the minimum required memory. The actual requirements depend on the configuration chosen at `sd_ble_enable()` time.
- The Firmware ID of this SoftDevice is 0x00A9.

New functionality

- SoftDevice
  - The SoftDevice API for advertising and scanning is updated and prepared to support future features. For more information, see the migration document (DRGN-9712).
  - The SoftDevice now has the functionality of write-protecting memory. This can be achieved by accessing the ACL peripheral configuration registers through `sd_protected_register_write()` (DRGN-8303).
- GAP
  - Channel number for RSSI measurement is now available in advertising reports (DRGN-9473).
  - Channel number for RSSI measurement is now available for connections (DRGN-9667).
  - API for channel survey (noise measurement) (DRGN-9580).
  - Support for setting channel map for the Observer role (DRGN-9518).
- LL
  - LE Coded PHY S=2 (500 kbps) coding scheme support for connected roles (DRGN-8474).
  - Active scanning for advertising extensions (DRGN-9735).
  - Scannable advertiser for advertising extensions (DRGN-9644).
  - Non-connectable non-scannable advertiser for advertising extensions (DRGN-9317).
  - Anonymous advertiser for advertising extensions (DRGN-9317).
  - Support for channel hopping on secondary channels for the extended advertiser (DRGN-8550).
  - Support for window widening for advertising extensions when following Aux Pointers (DRGN-9643).
  - Privacy support for extended advertising events in the advertiser role (DRGN-9235).
  - Support for Power Amplifier and Low Noise Amplifier (PA/LNA) for LE Coded PHY (DRGN-8166).

Changes

- SoftDevice

    - The SoftDevice now returns NRF_ERROR_BUSY from flash API functions until the event generated after a previous flash operation has been pulled (DRGN-9565).
    - The support for 9dBm TX power on nrf52840 has been removed. The maximum TX power supported is 8dBm (DRGN-9431).
    - The application now has access to both DC/DC converters of the nRF52840. See API in nrf_soc.h (DRGN-9122).
    - The application can now set the power failure comparator threshold value for high voltage using the sd_power_pof_thres holdvddh_set() API (DRGN-9123).
    - A message sequence chart for Unexpected Security Packet Reception has been added to Peripheral Security Procedures in the API documentation (DRGN-9479).
- GATT
    - The SoftDevice will now return NRF_ERROR_TIMEOUT instead of NRF_ERROR_BUSY from GATT API functions if a GATT procedure is blocked due to a previous procedure timeout (DRGN-9545).
    - Clarified API documentation: The length field in the parameter struct passed to sd_ble_gatts_hvx() may be written to by the SoftDevice (DRGN-9620).
- GAP
    - The sd_ble_gap_data_length_update() input parameter requirements have been relaxed. Previous requirements, which have now been removed, included symmetric input parameters and BLE_GAP_DATA_LENGTH_AUTO as the only valid input for max_tx_time_us and max_rx_time_us (DRGN-8499).
- LL
    - The documentation of the PHY Update procedure is improved (DRGN-9678).
    - Bluetooth Core Specification Erratum #7408 is incorporated, meaning that it is now accepted to receive an LL_UNKNOWN_RSP during encryption procedure (DRGN-8414).
    - Improved reception on LE Coded PHY in noisy environments by removing a workaround for ERRATA-164 that is only applicable to nRF52840 Engineering A (DRGN-9847).
    - The SoftDevice now sends LL_REJECT_EXT_IND instead of LL_REJECT_IND if the peer has indicated support for LL_REJECT_EXT_IND (DRGN-9539).

Bug fixes

- SoftDevice
    - Fixed an issue where sd_ble_gap_rssi_get() could sometimes return NRF_ERROR_SUCCESS with an invalid RSSI (DRGN-9746).
    - Fixed an issue where the HFXO would sometimes not be released properly after RC calibration (DRGN-9920).
    - Fixed an issue where the BLE_EVT_LEN_MAX(ATT_MTU) macro did not return the worst-case event length because it did not account for a corner case related to GATT primary service discovery response. This was fixed for s140_nrf52840_6.0.0-6.alpha, but was missing in the release notes (DRGN-9610).
    - Removed a limitation where Radio Notification could be suppressed between connection events when Connection Event Length Extension was enabled. This was fixed for s140_nrf52840_6.0.0-6.alpha, but was missing in the release notes (DRGN-7687).
    - Fixed an issue where flash writes would sometimes return NRF_ERROR_FORBIDDEN (DRGN-9144).
    - Fixed an issue where the LNA pin would be activated after the READY event from the radio for LE Coded PHY (DRGN-9868).
- GATT
    - Fixed an issue where the SoftDevice could drop a write request if it was received at the same time as a write command (DRGN-9709).
- GAP
    - Fixed an issue where sd_ble_gap_connect() could return NRF_SUCCESS when given invalid parameters (DRGN-9362).
    - Fixed an issue where sd_ble_gap_phy_update() would return NRF_ERROR_INTERNAL if the application preferred LE Coded PHY on a connection with short event length configuration (DRGN-9495).
    - Fixed an issue where the SoftDevice would sometimes not report the actual negotiated RX parameters in the BLE_GAP_EVT_DATA_LENGTH_UPDATE event (DRGN-9939).
    - Fixed an issue where the SoftDevice could assert if the white list and identity list were set at the same time with matching addresses (DRGN-9535).
- LL
    - Fixed an issue where the slave could disconnect with status code BLE_HCI_DIFFERENT_TRANSACTION_COLLISION if master sent an LL_UNKNOWN_RSP after a PHY procedure collision (DRGN-9870).
    - Fixed an issue where the slave could disconnect with a status code other than HCI_STATUS_CODE_PIN_OR_KEY_MISSING when LTK was missing (DRGN-9190).
    - Fixed an issue where connection establishment could fail on LE 2M PHY or LE Coded PHY (DRGN-9231).
    - Host is no longer allowed to set a PHY with lower bit rate if the connection event length is too short (DRGN-9154).
    - Fixed an issue where the SoftDevice as a slave might violate Bluetooth Core Specification v 5.0 timing restrictions if the master sent an LL_PHY_UPDATE_IND with Coded PHY (DRGN-9871).
    - Fixed an issue that could lead to high packet error rate when receiving on LE Coded PHY (DRGN-9793).
    - Fixed an issue where the SoftDevice might advertise with the RxAdd bit set to 1 for undirected advertisements. According to the Bluetooth Core Specification v 5.0, the RxAdd bit is reserved for future use for these PDU types (DRGN-9739).
    - Fixed an issue where the SoftDevice could assert if the identity list was used while advertising or scanning (DRGN-9723).
    - Fixed an issue that could cause an assert when generating advertising report for a directed advertising event (DRGN-9552).
    - Fixed an issue where the SoftDevice had problems connecting to non-Nordic devices using the LE Extended Advertising feature (DRGN-9543).

- Fixed an issue where the SoftDevice might send an LL_LENGTH_RSP with illegal values for TX/RX octets if the event length configured for the link was either 4 or 5 and LE 2M PHY was used (DRGN-9839).
- Fixed an issue where incorrect timing calculations during the LE Data Length Update procedure could lead to an assert (DRGN-9612).
- Fixed an issue where the SoftDevice could get stuck in a deadlock where it would always NACK what the peer was sending. This could happen if LE Data Packet Length Extension was used and `ble_cfg.conn_cfg.params.gap_conn_cfg.event_length` was less than 5. This was fixed for s140_nrf52840_6.0.0-6.alpha, but was missing in the release notes (DRGN-9494).
- Fixed an issue where the extended advertiser did not use the proper clock accuracy when switching between primary and secondary advertising channels (DRGN-8554).

Limitations

- SoftDevice
  - If Radio Notifications are enabled, flash write and flash erase operations initiated through the SoftDevice API will be notified to the application as Radio Events (FORT-809).
  - Synthesized low frequency clock source is not tested or intended for use with the BLE stack.
  - Applications must not modify the `SEVONPEND` flag in the `SCR` register when running in priority levels higher than 6 (priority level numerical values lower than 6) as this can lead to undefined behavior.
  - Applications aiming at initiating LE connections on LE Coded PHY must have configured the length of the connection event to be sufficiently large to transmit and receive at least one pair of data channel PDUs with a payload of 27 octets. Otherwise, the SoftDevice will not be able to connect on LE Coded PHY.
  - GPIO port 1 pins (P1.00 to P1.15) can not be used for PA/LNA on nRF52840 (DRGN-9995).
  - The LE Advertising Extension and LE Coded PHY implementations are incomplete and may not function as specified. These features are only suitable for development purposes, not production.
    - The main functionality that is missing is scanner privacy for advertising extensions, advertising and scanning AUX_CHAIN_IND PDUs, and advertising intervals longer than 10.24 s.
- GATTS
  - To conform to the Bluetooth Core Specification v 5.0, there shall be no secondary service that is not referenced somehow by a primary service. The SoftDevice does not enforce this (DRGN-906).
- LL
  - The Link-Layer payload size is limited to 27 bytes for LE Coded PHY (DRGN-8476, DRGN-9817).

Known Issues

- SoftDevice
  - If the application writes to protected memory, the SoftDevice HardFault handler can hang while trying to read an invalid value from the call stack (DRGN-9694).
  - If the application calls a NULL pointer, there will be a HardFault inside the SoftDevice HardFault handler (DRGN-9607).
  - If the application configures too many L2CAP Connection-oriented Channels in total for all connections, the SoftDevice will assert during `sd_ble_enable()`. Less than 150 channels are supported (DRGN-9946).
  - When the scanner times out, the source of the timeout event might be set to `BLE_GAP_TIMEOUT_SRC_CONN` instead of `BLE_GAP_TIMEOUT_SRC_SCAN`(DRGN-10000).
  - If `sd_ble_gap_addr_set()` or `sd_ble_gap_privacy_set()` is called after `sd_ble_gap_adv_set_configure()` and before `sd_ble_gap_adv_start()`, the advertiser will not update its address type (DRGN-10025).
  - If the application calls `sd_ble_gap_adv_set_configure()` with `ble_gap_adv_properties_t::type` set to a legacy advertising type and either `ble_gap_adv_properties_t::anonymous` or `ble_gap_adv_properties_t::include_tx_power` is set to 1, the SoftDevice will assert (DRGN-10024).
- LL
  - The SoftDevice might not respect the MaxTxOctets of the peer if the peer transmits on LE Coded PHY using the S=2 coding scheme (DRGN-9714).
  - The SoftDevice can assert while scanning on LE Coded PHY (DRGN-9932).
  - The packet error rate is high when receiving on LE Coded PHY in noisy environments (DRGN-9768).

s140_nrf52840_6.0.0-6.alpha

This release continues the series of S140 alpha releases. But for this release, the major version number has been incremented from 5 to 6. This is done for consistency with previous and future SoftDevice releases and has no other significance.

The main change in the s140_nrf52840_6.0.0-6.alpha version, as compared to the s140_nrf52840_5.0.0-3.alpha version, is support for L2CAP Connection-Oriented Channels and application control of the PHY Update Procedure.

Notes:

- This release has changed the Application Programmer Interface (API). This requires applications to be recompiled.
- The memory requirements of the s140 SoftDevice have changed.

SoftDevice properties

- This alpha version of the SoftDevice contains the Master Boot Record (MBR) version 2.3.0-1.alpha (DRGN-8852).
- The combined MBR and SoftDevice memory requirements for this version are as follows:
  - Flash: **148 kB** (`0x25000` bytes).
  - RAM: **5.296 kB** (`0x1530` bytes) This is the minimum required memory. The actual requirements depend on the configuration chosen at `sd_ble_enable()` time.

New functionality

- SoftDevice
  - The SoftDevice API now provides access to USB power handling registers (DRGN-7793).
- L2CAP
  - Connection-Oriented Channels in LE Credit Based Flow Control Mode (DRGN-8572).
- LL
  - The SoftDevice now implements a range delay (packet time of flight compensation) corresponding to a distance of 5 km when using LE Coded PHY (DRGN-9069).
  - The SoftDevice now supports Channel Selection algorithm #2 (DRGN-7147).
  - PA/LNA is now supported for LE 2M PHY and LE Coded PHY (DRGN-8259).
  - Support for Network Privacy Mode has been added (DRGN-8658).

Changes

- SoftDevice
  - Add SoftDevice unique string in the SoftDevice info structure (DRGN-7852).
  - Interrupt priority 5 is now available to the application (DRGN-8853).
- GAP
  - The application is now given control of the PHY update procedure (DRGN-8473). The application can initiate the PHY update procedure and has to respond when the procedure is initiated by the peer.
  - The SoftDevice now supports the configuration of Tx power per link and per role (DRGN-6659).
  - In Bluetooth Specification Version 5.0, the definition of LE Security Mode 1 Level 4 has changed. LESC MITM protected encrypted link using a 128-bit strength encryption key is now required (DRGN-8759).
  - `BLE_GAP_EVT_TIMEOUT {src: BLE_GAP_TIMEOUT_SRC_SECURITY_REQUEST}` is replaced with `BLE_GAP_EVT_AUTH_STATUS {auth_status: BLE_GAP_SEC_STATUS_TIMEOUT}` (DRGN-8752).
  - `BLE_GAP_ADV_NONCON_INTERVAL_MIN` is now removed (DRGN-8611).
  - Stack will no longer return `NRF_ERROR_BUSY` when calling `sd_ble_gap_connect()`, `sd_ble_gap_scan_start()`, `sd_ble_gap_authenticate()`, or `sd_ble_gap_adv_start()` (DRGN-8843).
  - Stack will now only return `NRF_ERROR_BUSY` on `sd_ble_gap_conn_param_update()` when a connection parameter update is already in progress (DRGN-8843).
  - A flag `lesc` is added to the `ble_gap_evt_auth_status_t` struct, indicating if an authentication procedure has resulted in an LE Secure Connection (DRGN-7801).
- LL
  - The SoftDevice slave role now accepts overlapping peer-initiated Link Layer control procedures (DRGN-8623). The following LL control procedures can be executed in parallel with any other control procedure, except for themselves: LE Ping, Feature Exchange, Data Length Update, and Version Exchange. This is done for compatibility reasons.
  - The SoftDevice now has improved control procedure performance in scenarios involving multiple links (DRGN-9001).

Bug fixes

- SoftDevice
  - Fixed the implementation in `sd_flash_protect()`, allowing it to support SoftDevice flash size > 128 kB (DRGN-8710)
  - Fixed an issue where calling `sd_ble_gap_sec_params_reply()`, `sd_ble_user_mem_reply()`, or `sd_ble_gatts_rw_authorize_reply()` more than 6 times without pulling events in between would in some cases lead to link disconnect (DRGN-8627)
  - Fixed an issue where the SoftDevice could trigger a BusFault when forwarding a HardFault to the application (DRGN-8604).
  - Fixed an issue where `sd_ble_enable()` may corrupt up to 8 bytes above the returned `app_ram_base` when the SoftDevice is configured with 0 Peripheral roles and 0 Central roles (DRGN-8802).

- GAP
  - Fixed an issue where the SoftDevice was disallowing the application to set new advertising data after configuring an extended advertiser (DRGN-9134).
  - Fixed an issue where calling `sd_ble_gap_privacy_get()` could cause a hardfault (DRGN-8899).
  - Fixed an issue where the `BLE_GAP_DATA_LENGTH_AUTO` value for `p_dl_params->max_tx_octets` and `p_dl_params->max_rx_octets` in `sd_ble_gap_data_length_update()` might not work as expected on connections using a configuration with configured event length of 2, 3, or 4 (DRGN-8779).
- LL
  - Fixed an issue that was causing a sensitivity drop on LE Coded PHY (DRGN-9108). This issue could have lead to reduced range.
  - Fixed an issue where a peripheral accepted a PHY_UPDATE_IND packet which indicated PHYs that had not been negotiated in the PHY update procedure (DRGN-8135).
  - Fixed an issue where a central in some cases did not send a REJECT_EXT_IND packet in a valid control procedure collision scenario (DRGN-8926).
  - Fixed an issue with T_IFS violation in LE connection events with asymmetric PHYs (TX: 1MPHY, RX: 2MB PHY) (DRGN-8762).
  - Fixed an issue where the PA/LNA implementation for symmetric 1M PHY LE connections asserted the PA pin too early (DRGN-8782).
  - Fixed an issue where `BLE_HCI_STATUS_CODE_LMP_RESPONSE_TIMEOUT` was reported as disconnect reason when TERMINATE_IND packet was not acknowledged. The reason is now correctly reported as `BLE_HCI_LOCAL_HOST_TERMINATED_CONNECTION` (DRGN-8837).
  - Fixed an issue that was causing a REM request to be blocked indefinitely if a REM session uses the REM extend feature (DRGN-8859).
  - Fixed an issue where a central would ignore any received LL_REJECT_EXT_IND PDUs (DRGN-8737).
  - Fixed an issue where a peripheral ignored a received LL_UNKNOWN_RSP after an LL_PHY_RSP was sent (DRGN-8134)
  - Fixed an issue where the SoftDevice would only be able to send two packets per connection event after a Data Length Update Procedure to a LL Data Channel PDU payload size of more than 34 bytes (DRGN-8392).
  - Fixed an issue where the SoftDevice could assert if scan parameters are updated after the scanner has accepted a new LE connection (DRGN-8635).
  - The SoftDevice no longer accepts `LL_PHY_REQ` and `LL_PHY_RSP` with empty TX and/or RX PHY fields (DRGN-7950).
  - Fixed an issue where the encryption of long link layer packets (payload length greater than 27 bytes) over 2 Mbps PHY could lead to MIC failures and cause the peer to disconnect (DRGN-8748).

Limitations

- SoftDevice
  - If Radio Notifications are enabled, flash write and flash erase operations initiated through the SoftDevice API will be notified to the application as Radio Events (FORT-809).
  - Synthesized low frequency clock source is not tested or intended for use with the BLE stack.
  - Applications must not modify the `SEVONPEND` flag in the `SCR` register when running in priority levels higher than 6 (priority level numerical values lower than 6) as this can lead to undefined behavior.
  - Applications aiming at initiating LE connections on LE Coded PHY must have configured the length of the connection event to be sufficiently large to transmit and receive at least 1 pair of Data channel PDUs with a payload of 27 octets. Otherwise, the SoftDevice will not be able to connect on LE Coded PHY.
- GATTS
  - To conform to the Bluetooth specification, there shall not be a secondary service that is not referenced somehow by a primary service. The SoftDevice does not enforce this (DRGN-906).
- LL
  - The Link-Layer payload size is limited to 27 bytes for LE Coded PHY

Known Issues

- SoftDevice
  - If Connection Event Length Extension is enabled, the Radio Notification may be suppressed between connection events (DRGN-7687).

- GAP
  - `sd_ble_gap_phy_update()` will return `NRF_ERROR_INTERNAL` when the application prefers LE Coded PHY on a connection with low event length configuration (DRGN-9495). To avoid this, configure an event length of 6 or above using `sd_ble_cfg_set()`.

s140_nrf52840_5.0.0-3.alpha

The main change in the 5.0.0-3.alpha version, as compared to the 5.0.0-2.alpha version, is support for establishing Bluetooth LE connections directly on Long Range (that is using LE Coded PHY).

Notes:

- The Application Programming Interface (API) in the 5.0.0-3.alpha has been changed as compared to the API in the 5.0.0-2 alpha release. This requires applications to be modified in order to adapt to the proper usage of the new API.
- The memory requirements of the s140 SoftDevice have changed.

SoftDevice properties

- This alpha version of the SoftDevice contains the Master Boot Record (MBR) version 2.1.0.
- The combined MBR and SoftDevice memory requirements for this version are as follows:
  - Flash: **143 kB** (`0x24000` bytes).
  - RAM: **5.18 kB** (`0x14B8` bytes) This is the minimum required memory. The actual requirements depend on the configuration chosen at `sd_ble_enable()` time.

New functionality

- The SoftDevice now supports establishing LE connections directly on either 2MBPS or LE Coded PHY (Long Range) in addition to 1MBPS (DRGN-8280 and DRGN-8274).
- The SoftDevice now supports sleep clock accuracy values less than 20 ppm as a peripheral (DRGN-8158).
- The application can now set the sleep clock accuracy for the RC oscillator (DRGN-8666).

Changes

- SWI3 is no longer reserved for use by the SoftDevice and is available for the application (DRGN-8367).

Bug fixes

- Documentation
  - Fixed documentation for `sd_ble_gap_addr_set()` and `sd_ble_gap_privacy_set() (DRGN-8624).`
- SoftDevice
  - The `sd_power_pof_threshold_set` API has been fixed to support all the new levels that were introduced in nRF52 (DRGN-8348).
  - Fixed an issue where scanning or advertising with timeout greater than 256 seconds and having two host protocol timers running at the same time might lead to delayed timeouts (DRGN-7804).
- GAP
  - Fixed an issue where the `conn_handle` parameter in the event `BLE_GAP_EVT_DATA_LENGTH_UPDATE_REQUEST` was not populated correctly (DRGN-8749).
  - Fixed an issue where the SoftDevice would assert when `sd_ble_gap_device_identities_set()` was called while advertiser is running (DRGN-8634).
  - Fixed an issue where `sd_ble_gap_conn_param_update()` called in peripheral role may in some cases return NRF_ERROR_BUSY for 30 seconds after the previous procedure initiated by that call was completed (DRGN-8577).
- GATTC
  - It is no longer possible to issue a write command if the write command queue size is set to 0 on the config API (DRGN-8353).
- GATTS
  - Fixed an issue where incoming packet processing may be delayed in some cases until the application replies with the `sd_ble_user_mem_reply()` call when the `BLE_EVT_USER_MEM_REQUEST` event is pulled by the application (DRGN-8595).
  - Fixed an issue where the value of the attribute in `BLE_GATTS_EVT_RW_AUTHORIZE_REQUEST` event corresponding to the first Prepare Write Request on a link with heavy traffic may get corrupted if the application delays the pulling of SoftDevice events (DRGN-8595).
  - It is no longer possible to issue an HVN if the HVN queue size is set to 0 on the config API (DRGN-8353).

- LL
  - Fixed an issue where using more than eight links and receiving a lot of data concurrently could lead to undefined behavior (DRGN-8433).
  - Fixed an issue where using encryption on multiple master links at the same time could cause an assert (DRGN-8532).

Limitations

- SoftDevice
  - If Radio Notifications are enabled, flash write and flash erase operations initiated through the SoftDevice API will be notified to the application as Radio Events (FORT-809).
  - Synthesized low frequency clock source is not tested or intended for use with the BLE stack.
  - Applications must not modify the `SEVONPEND` flag in the `SCR` register when running in priority levels higher than 6 (priority level numerical values lower than 6) as this can lead to undefined behavior.
  - Applications aiming at initiating LE connections on LE Coded PHY must have configured the length of the connection event to be sufficiently large to transmit and receive at least 1 pair of Data channel PDUs with a payload of 27 octets. Otherwise, the SoftDevice will not be able to connect on LE Coded PHY.
- GATTS
  - To conform to the Bluetooth specification, there shall not be a secondary service that is not referenced somehow by a primary service. The SoftDevice does not enforce this (DRGN-906).
- LL
  - For LE Coded PHY and 2 MBPS, see the section "Using LE Coded PHY and 2 Mbps" below.
  - PA/LNA is not supported for LE Coded PHY and 2Mbps (DRGN-8166).

Using LE Coded PHY and 2 Mbps

This alpha version of the SoftDevice supports LE connection establishment using legacy advertising or Advertising Extensions. Applications may use legacy advertising to establish connections on 1 Mbps or Advertising Extensions to establish connections on either 1 Mbps, 2 Mbps, or LE Coded PHY. After connections are established on any PHY, applications may initiate a PHY Update procedure to attempt to modify the connection TX and RX PHYs.

The following table shows the supported PHY combinations of this SoftDevice when using LE Coded PHY and 2 Mbps. Encrypted links are not supported in all combinations as indicated in the table. Where encryption is not supported, the link must be established with 1 Mbps PHY and not encrypted before changing PHY.

PHY		**Max PDU payload size**		**Encryption support**
TX	**RX**	**TX**	**RX**	
1 Mbps	1 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	27	27	Yes
1 Mbps	Coded (S=8)	27	27	Yes
2 Mbps	1 Mbps	up to 251	up to 251	No
2 Mbps	1 Mbps	27	27	Yes
2 Mbps	2 Mbps	up to 251	up to 251	No
2 Mbps	2 Mbps	27	27	Yes
2 Mbps	Coded (S=8)	27	27	Yes
Coded (S=8)	1 Mbps	27	27	Yes
Coded (S=8)	2 Mbps	27	27	Yes
Coded (S=8)	Coded (S=8)	27	27	Yes

Note: This alpha version of the SoftDevice does not support the 500 kbps bit rate (S=2 encoding scheme).

Known Issues

- SoftDevice

- If Connection Event Length Extension is enabled, the Radio Notification may be suppressed between connection events (DRGN-7687).
- Calling `sd_ble_gap_sec_params_reply()`, `sd_ble_user_mem_reply()`, or `sd_ble_gatts_rw_authorize_reply()` more than six times without pulling events in between may in some cases lead to link disconnect (DRGN-8627).
- If the SoftDevice is configured with 0 Peripheral roles and 0 Central roles, `sd_ble_enable()` may corrupt up to 8 bytes above the returned `app_ram_base`. For applications that have such a configuration, set the application RAM start to 8 bytes or more above the returned `app_ram_base` (DRGN-8802).

- GAP
  - The `BLE_GAP_DATA_LENGTH_AUTO` value for `p_dl_params->max_tx_octets` and `p_dl_params->max_rx_octets` in `sd_ble_gap_data_length_update()` does not work as expected on connections using a configuration with configured event length of 2, 3 or 4, when maximum ATT_MTU in the same connection configuration is more than 69, 147 or 225 octets respectively. In these cases, `sd_ble_gap_data_length_update()` will return error code `NRF_ERROR_RESOURCES`, and not have an effect (DRGN-8779).
- LL
  - Encryption of long link layer packets (payload length greater than 27 bytes) over 2 Mbps PHY leads to MIC failures and causes the peer to disconnect (DRGN-8748).

s140_nrf52840_5.0.0-2.alpha

The s140 is a SoftDevice for the nRF52840 chip.

The main changes of this version compared to the previous alpha is that the features and API of s132 4.0.0 have been integrated. This includes application control of the Data Length Update Procedure, SoftDevice configuration API extensions, support for multiple peripheral connections, support for up to 20 connections in total, and configuration of individual links including per link ATT_MTU configuration. The API is now the same as for S132 4.0.0 with some additions for s140-specific features.

Notes:

- This release has changed the API from the previous s140 alpha. This requires applications to be recompiled.
- The memory requirements of the SoftDevice have changed.

SoftDevice properties

- This version of the SoftDevice contains the Master Boot Record (MBR) version 2.1.0 (DRGN-8507).
  - The changes from the previous version are header file modifications only.
- The combined MBR and SoftDevice memory requirements for this version are as follows:
  - Flash: **133 kB** (`0x21400` bytes).
  - RAM: **5.10 kB** (`0x1468` bytes) This is the minimum required memory. The actual requirements depend on the configuration chosen at `sd_ble_enable()` time.

New functionality

- SoftDevice
  - Support for sleep clock accuracy values less than 20 ppm as a peripheral (DRGN-8158).
- BLE
  - Support for 20 links in total with freely selectable role (Central/Peripheral) for each link (DRGN-7102, DRGN-7152, DRGN-7848).
  - The BLE bandwidth configuration and application packet concept has been replaced with per link configurable:
    - Event length (DRGN-7858)
    - Write without response queue size (DRGN-7488, DRGN-7858)
    - Handle Value Notification queue size (DRGN-7487, DRGN-7858)
  - The GPIO pin to toggle can now be the same for PA and LNA (DRGN-8354).
- GAP
  - The event length (i.e. the time set aside on every connection interval) can now be configured per link by the application (DRGN-7858).
  - The application is given control of the Data Length Update Procedure. The application can initiate the Data Length Update Procedure and has to respond when initiated by the peer (DRGN-8297).
- GATT
  - The maximum ATT_MTU can now be configured per link by the application (DRGN-7858).
- GATTC
  - The application packet concept has been replaced with a dedicated transmission queue for Write without responses. Also, the `BLE_EVT_TX_COMPLETE` event has been replaced with `BLE_GATTC_EVT_WRITE_CMD_TX_COMPLETE`. Write without response queue size can now be configured per link by the application (DRGN-7488, DRGN-7858).
- GATTS
  - The application packet concept has been replaced with a dedicated transmission queue for Handle Value Notifications. Also, the `BLE_EVT_TX_COMPLETE` event has been replaced with `BLE_GATTS_EVT_HVN_TX_COMPLETE`. Handle Value Notification queue size can now be configured per link by the application (DRGN-7487, DRGN-7858).
- LL
  - The SoftDevice can be configured to disable and enable slave latency (DRGN-8305). This allows the application to override the slave latency set by the master.
  - The SoftDevice can be configured to not disconnect if the peer initiates parallel version and feature exchange procedures (DRGN-8306).

Changes

- SoftDevice
  - The `sd_power_ramon_set()`, `sd_power_ramon_clr()`, and `sd_power_ramon_get()` SoftDevice APIs have been replaced with `sd_power_ram_power_set()`, `sd_power_ram_power_clr()`, and `sd_power_ram_power_get()`. The application therefore now has access to the registers `RAM[x].POWER` instead of the deprecated `RAMON/RAMONB` (DRGN-8117).
  - SWI3 is no longer reserved for use by the SoftDevice and is available for the application (DRGN-8367).
- BLE
  - More pointers have been defined as `const` in the BLE API, allowing the application to put more data into flash instead of RAM, if desired (DRGN-6133).
  - Configuration parameters passed to `sd_ble_enable()` have been moved to the SoftDevice configuration API (DRGN-8107).

Bug fixes

- SoftDevice
  - `sd_softdevice_enable()` now returns an error code if called with `fault_handler` set to `NULL` or to an invalid function pointer. If the application returns from the `fault_handler` function, the SoftDevice will do an `NVIC_SystemReset()` (DRGN-7122).
  - It is no longer required to clear `INTENSET` for `TIMER0` before the timeslot ends if the application uses `TIMER0` inside a timeslot scheduled with the Radio Timeslot API (DRGN-7776).
  - The `SVCALL` macro can now be used also with the GCC C++ compiler (DRGN-8028).
  - The sd_power_pof_threshold_set API has been fixed to support all the new levels that were introduced in nRF52 (DRGN-8348).
  - Fixed an issue where nRF52840 was not supported in nrf_nvic.h and nrf_soc.h headers (DRGN-8407).
  - Fixed an issue where scanning or advertising with timeout greater than 256 seconds and having two host protocol timers running at the same time might lead to delayed timeouts (DRGN-7804).
- BLE
  - Several documentation errors have been corrected (DRGN-7386, DRGN-7853, DRGN-8136).
- GATTC
  - It is no longer possible to issue a write command if the write command queue size is set to 0 on the config API (DRGN-8353).
- GATTS
  - It is no longer possible to issue an HVN if the HVN queue size is set to 0 on the config API (DRGN-8353).
- GAP
  - Two missing Advertising Data Types have been added: `BLE_GAP_AD_TYPE_LESC_CONFIRMATION_VALUE` (0x22) and `BLE_GAP_AD_TYPE_LESC_RANDOM_VALUE` (0x23) (DRGN-8101).
  - `sd_ble_gap_connect()` now always stops the scanner (DRGN-7679).
  - Fixed an issue where `sd_ble_gap_conn_param_update()` called in peripheral role in some cases may return NRF_ERROR_BUSY for 30 seconds after the previous procedure initiated by that call was completed (DRGN-8577).
- LL
  - Fixed an issue where the controller completed a procedure when it received an `LL_UNKNOWN_RSP` without checking if it was the expected procedure that returned the error opcode (DRGN-7999).
  - The SoftDevice no longer rejects `LL_LENGTH_REQ` and `LL_LENGTH_RSP` with parameters which are out of range according to Bluetooth 4.2 specification (DRGN-7872).
  - Fixed an issue where bit errors in the length field of an encrypted packet caused the packet to be interpreted as longer than was sent by the peer (DRGN-7898). This issue could have manifested in the following ways:
    - SoftDevice memory buffer corruption which could lead to an assert or incorrect behavior.
    - SoftDevice may send a packet with an incorrect MIC field leading to a disconnect from the peer.
  - Fixed an issue where a connection parameter update from a short connection interval to a longer connection interval when using long ATT MTUs could lead to reduced bandwidth (DRGN-8427).
  - Fixed an issue where using encryption on multiple master links at the same time could cause an assert (DRGN-8532).

Limitations

- SoftDevice
  - If Radio Notifications are enabled, flash write and flash erase operations initiated through the SoftDevice API will be notified to the application as Radio Events (FORT-809).
  - Synthesized low frequency clock source is not tested or intended for use with the BLE stack.
  - Applications must not modify the `SEVONPEND` flag in the `SCR` register when running in priority levels higher than 6 (priority level numerical values lower than 6) as this can lead to undefined behavior.
  - The SV-calls `sd_mbr_command_vector_table_base_set()` and `sd_mbr_command_copy_bl()` are not supported (DRGN-8197). Using these calls leads to undefined behavior.
  - The SV-calls `sd_flash_write()` and `sd_flash_page_erase()` do not check whether the flash pages being written or erased are write protected by ACL. Calling these functions on protected flash memory leads to undefined behavior (DRGN-8307, DRGN-8308).

- LL
  - For LE Coded PHY and 2 Mbps, see the section "Using LE Coded PHY and 2 Mbps" below.
  - PA/LNA is not supported for LE Coded PHY and 2Mbps (DRGN-8166).
- GATTS
  - To conform to the Bluetooth specification, there shall not be a secondary service that is not referenced somehow by a primary service. The SoftDevice does not enforce this (DRGN-906, DRGN-2260).

Using LE Coded PHY and 2 Mbps

This alpha version of the SoftDevice supports connection establishment using the 1 Mbps PHY and changing to use the other PHY options (2 Mbps and 125 kbps, also known as Coded S=8). It does not support connection with other PHY configurations. The link must be established first in 1 Mbps PHY and then the PHY can be changed using the above mentioned SV call.

The following table shows the supported PHY combinations of this alpha version of the SoftDevice when using LE Coded PHY and 2 Mbps. Encrypted links are not supported in all combinations as indicated in the table. Where encryption is not supported, the link must be established with 1 Mbps PHY and not encrypted before changing PHY.

PHY		Max PDU payload size		Encryption support
TX	**RX**	**TX**	**RX**	
1 Mbps	1 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	27	27	Yes
1 Mbps	Coded (S=8)	27	27	Yes
2 Mbps	1 Mbps	up to 251	up to 251	No
2 Mbps	1 Mbps	27	27	Yes
2 Mbps	2 Mbps	up to 251	up to 251	No
2 Mbps	2 Mbps	27	27	Yes
2 Mbps	Coded (S=8)	27	27	Yes
Coded (S=8)	1 Mbps	27	27	Yes
Coded (S=8)	2 Mbps	27	27	Yes
Coded (S=8)	Coded (S=8)	27	27	Yes

Note: This alpha version of the SoftDevice does not support the 500 kbps bit rate (S=2 encoding scheme).

Known issues

SoftDevice

- If Connection Event Length Extension is enabled, the Radio Notification may be suppressed between connection events (DRGN-7687).

GAP

- **Update 1:** The `conn_handle` parameter in the event `BLE_GAP_EVT_DATA_LENGTH_UPDATE_REQUEST` is not populated correctly (DRGN-8749).
- **Update 1:** The `BLE_GAP_DATA_LENGTH_AUTO` value for `p_dl_params->max_tx_octets` and `p_dl_params->max_rx_octets` in `sd_ble_gap_data_length_update()` does not work as expected on connections using a configuration with configured event length of 2, 3 or 4, when maximum ATT_MTU in the same connection configuration is more than 69, 147 or 225 octets respectively. In these cases `sd_ble_gap_data_length_update()` will return error code `NRF_ERROR_RESOURCES`, and not have an effect (DRGN-8779).

LL

- Encryption of long link layer packets (payload length greater than 27 bytes) over 2 Mbps PHY leads to MIC failures and causes the peer to disconnect (DRGN-8356).

GATTS

- When BLE_EVT_USER_MEM_REQUEST event is pulled by the application, incoming packet processing may be delayed in some cases until the application replies with the `sd_ble_user_mem_reply()` call (DRGN-8595).
- The value of the attribute in BLE_GATTS_EVT_RW_AUTHORIZE_REQUEST event corresponding to the first Prepare Write Request on a link with heavy traffic may get corrupted if application delays the pulling of SoftDevice events (DRGN-8595).
- The SoftDevice is incorrectly identified as s132 in the SoftDevice information structure (DRGN-8363).

Documentation

- The documentation for `sd_ble_gap_addr_set()` and `sd_ble_gap_privacy_set()` states that these functions cannot be called while BLE roles are running. This is wrong. These functions can be called while in connection, but not while advertising, scanning, or creating a connection (DRGN-8624).

The documentation for `sd_ble_adv_start()` states that a connectable advertiser cannot be started after the BLE_GAP_EVT_CONNECTED event is received. This is wrong. A connectable advertiser can be started as long as no other advertiser is running and there are fewer active Peripheral connections than configured (DRGN-8624).

s140_nrf52840_5.0.0-1.alpha

The s140 is a SoftDevice for the nRF52840 chip. This release, s140_nrf52840_5.0.0-1.alpha, is the first alpha release of the s140.

The s140 is based upon Nordic Semiconductor's s132 SoftDevice. These release notes list the changes and differences from **s132_nrf52_3.0.0**.

Notes:

This is a major release which has changed the Application Programmer Interface (API) from the s132, requiring applications to be recompiled.

SoftDevice properties

The combined MBR and SoftDevice memory requirements for this version are as follows:

Flash: **132 kB** (`0x21000` bytes).

RAM: **6.43 kB** (0x19C0 bytes) (minimum required memory - actual requirements are dependent upon the configuration chosen at `sd_ble_enable()` time).

New functionality

LL

- Support for transmitting and receiving on the 2 Mbps PHY has been added (DRGN-7552).
- Support for transmitting and receiving on LE Coded PHY (Long Range) using the 125 kbps bit rate (S=8 encoding scheme) has been added (DRGN-5702).

Using LE Coded PHY and 2 Mbps

The SoftDevice provides a new GAP option `BLE_GAP_OPT_PREFERRED_PHYS_SET`, a new SV call `sd_ble_gap_phy_request()`, and a new event, `BLE_GAP_EVT_PHY_UPDATE` to support the new PHYs. Please read the API documentation for more details about these.

This alpha version of the SoftDevice supports connection establishment using the 1 Mbps PHY and changing to use the other PHY options (2 Mbps and 125 kbps (Coded S=8)). It does not support connection with other PHY configurations. The link must be established first in 1 Mbps PHY and then the PHY can be changed using the above mentioned SV call.

The following table shows the supported PHY combinations of this alpha version of the SoftDevice when using LE Coded PHY and 2 Mbps. Encrypted links are not supported in all combinations as indicated in the Table. Where encryption is not supported, the link must be established with 1 Mbps PHY and not encrypted before changing PHY.

PHY		Max PDU payload size		Encryption support
TX	**RX**	**TX**	**RX**	
1 Mbps	1 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	up to 251	up to 251	Yes
1 Mbps	2 Mbps	27	27	Yes
1 Mbps	Coded (S=8)	27	27	Yes
2 Mbps	1 Mbps	up to 251	up to 251	No
2 Mbps	1 Mbps	27	27	Yes
2 Mbps	2 Mbps	up to 251	up to 251	No

2 Mbps	2 Mbps	27	27	Yes
2 Mbps	Coded (S=8)	27	27	Yes
Coded (S=8)	1 Mbps	27	27	Yes
Coded (S=8)	2 Mbps	27	27	Yes
Coded (S=8)	Coded (S=8)	27	27	Yes

Note: This alpha version of the SoftDevice does not support the 500 kbps bit rate (S=2 encoding scheme).

Changes

GAP

- The SV-call `sd_ble_gap_tx_power_set()` is extended to support higher TX power (up to +9dBm) (DRGN-8310).

Bug fixes

There are no bug fixes in this release.

Limitations

SoftDevice

- If Radio Notifications are enabled, flash write and flash erase operations initiated through the SoftDevice API will be notified to the application as Radio Events (FORT-809).
- Synthesized low frequency clock source is not tested or intended for use with the BLE stack.
- Applications must not modify the `SEVONPEND` flag in the `SCR` register when running in priority level 1 as this can lead to undefined behavior.
- If the application uses TIMER0 inside a timeslot (scheduled with the Radio Timeslot API), INTENSET for TIMER0 must be cleared before the timeslot ends (DRGN-7776).
- The SV-calls `sd_mbr_command_vector_table_base_set()` and `sd_mbr_command_copy_bl()` are not supported (DRGN-8197). Using these calls leads to undefined behavior.
- The SV calls `sd_flash_write()` and `sd_flash_page_erase()` do not check whether the flash pages being written or erased are write protected by ACL. Calling these functions on protected flash memory leads to undefined behavior (DRGN-8307).

LL

- The peripheral role has priority over the central role when it comes to keeping the links alive.
- For LE Coded PHY and 2 Mbps, see the section "Using LE Coded PHY and 2 Mbps" above.

GAP

- A broadcaster **and** a scanner cannot both be active if there are 8 connections established (DRGN-6543).

GATTS

- To conform to the Bluetooth specification there shall not be a secondary service that is not referenced somehow by a primary service. The SoftDevice does not enforce this (DRGN-906, DRGN-2260).

Known Issues

If `sd_softdevice_enable()` is called with `fault_handler` set to `NULL`, an invalid function pointer, or a pointer to a returning function, the behavior will be undefined (DRGN-7122).

If Connection Event Length Extension is enabled, the Radio Notification may be suppressed between connection events (DRGN-7687).

When `sd_ble_gap_connect()` returns an error code, the scanner may be stopped (DRGN-7679). To ensure the scanner is in a known state, `sd_ble_gap_scan_stop()` should be used to stop the scanner when `sd_ble_gap_connect()` returns an error code.

Encryption of long link layer packets (payload length > 27 bytes) over 2 Mbps PHY leads to MIC failures and causes the peer to disconnect (DRGN-8356).

The SoftDevice is incorrectly identified as s132 in the SoftDevice information structure (DRGN-8363).