
# SoftDevice

Short introduction to the Nordic Bluetooth Low Energy protocol stacks (SoftDevices)

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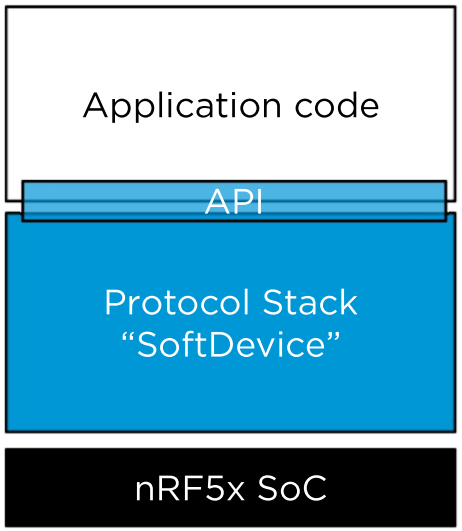
# nRF5x SoftDevices




- Nordic’s Protocol stacks for Bluetooth Low Energy
- Pre-compiled and pre-qualified.
- Application uses a simple API layer to communicate with the Softdevice.
- Application and protocol stack code is separated.
  - No link time dependencies
- No proprietary application framework
  - No scheduler or RTOS dependencies

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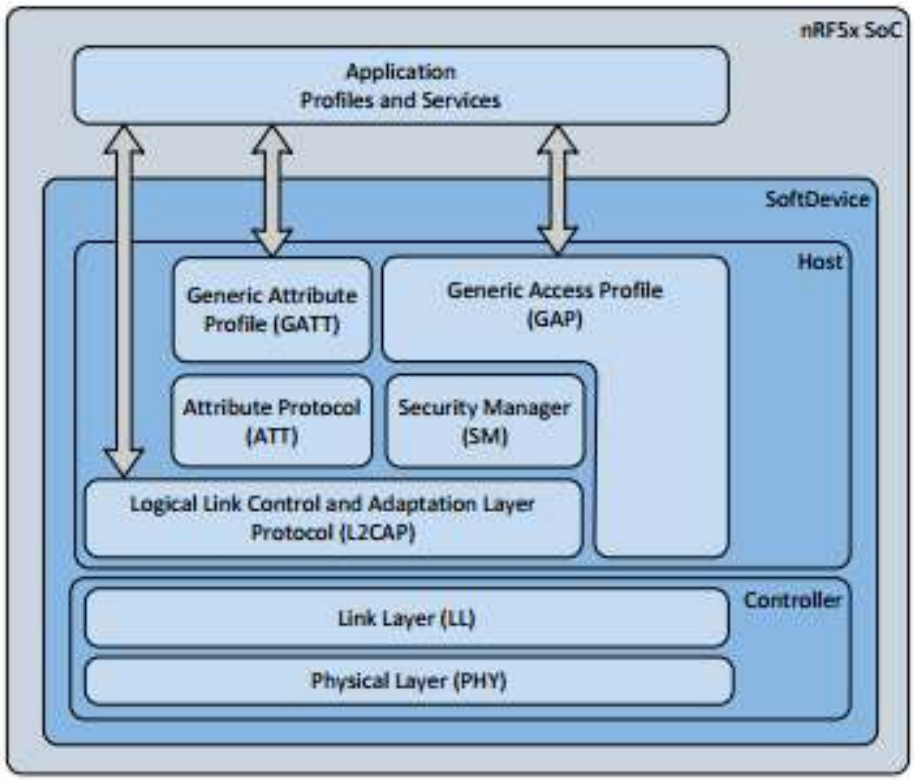
# SoftDevice up close

- Covers all the layers up to the application layer.
- Application has access to top modules through the SoftDevice API:
  - Generic Attribute Protocol (GATT),
  - Generic Access Profile (GAP),
  - Logical Link Control and Adaptation Protocol (L2CAP)




Example: S132 *Bluetooth* low energy protocol stack

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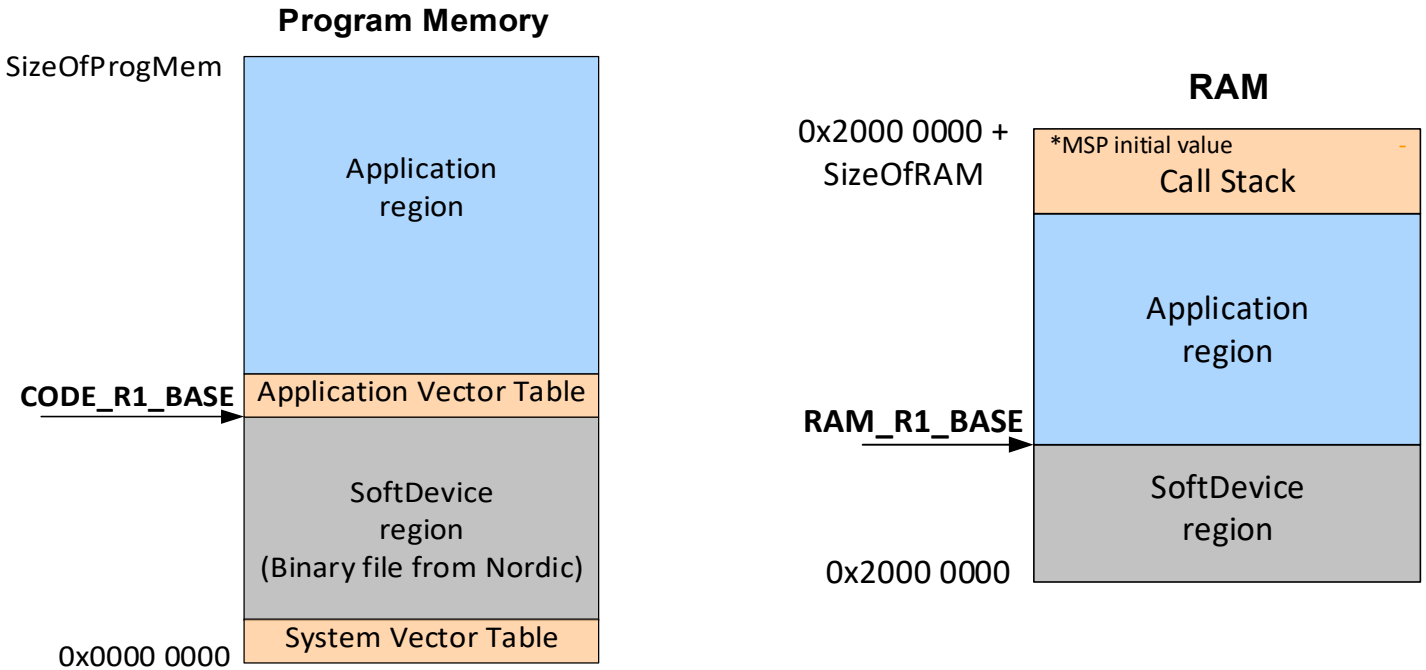
# Memory layout



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# SoftDevice API implementation

application.c

```
// Use the SoftDevice API functions as normal C functions.
#include "ble_gap.h"
sd_ble_gap_connect(…);
```

application.h

```
// The functions are definitions that expands to SVCs.
uint32_t __svc(SD_BLE_GAP_CONNECT) sd_ble_gap_connect(…);
```

softdevice.c

```
// SoftDevice functions are called from the
// SVC_Handler interrupt routine.
void SVC_Handler(int svc_num, int *svc_args)
{
    switch(svc_number)
    {
…
        case SD_BLE_GAP_CONNECT:
            sd_ble_gap_connect();
```

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# SoftDevice API implementation

- SoftDevice API calls in the Application cause software interrupts in the SoftDevice where the function is executed.
- The SoftDevice events are signaled to the Application by triggering a software interrupt (SWI).

```
// SWI2 -> SoftDevice Event Notification
void SWI2_EGU2_IRQHandler(void)
{
    // Poll for SoftDevice events.
}
```

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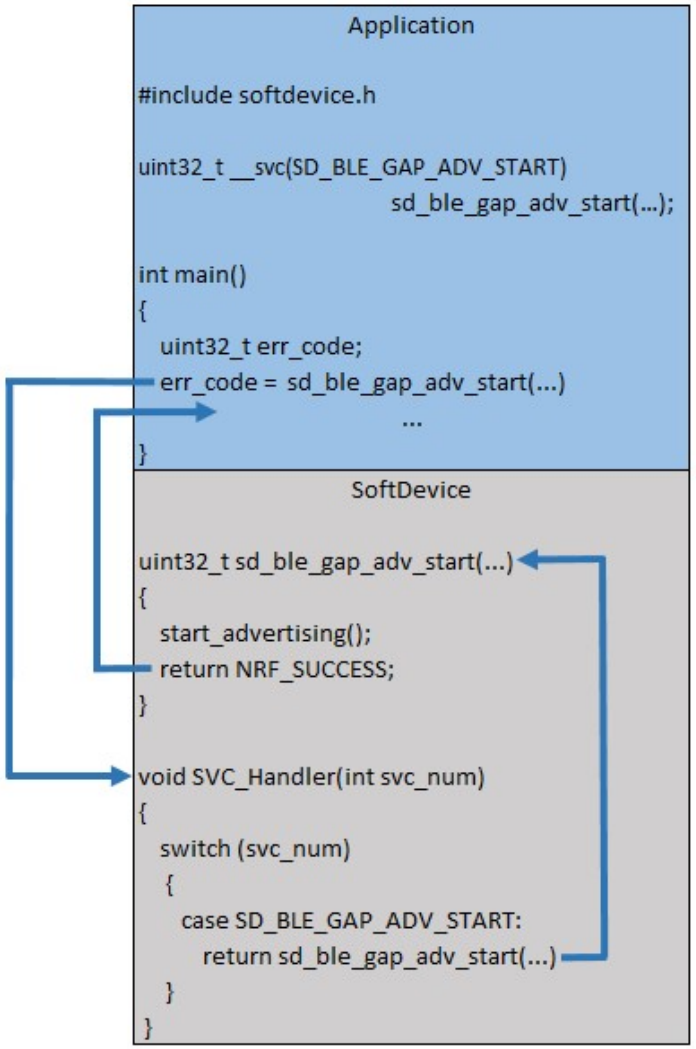
# SoftDevice API Execution

1. Call sd_-function in the application.
2. Function call triggers software interrupt passing the function number to the SoftDevice.
3. SoftDevice enters the SW interupt handler, checks function number and calls the corresponding function.
4. The return value of the function is then passed to the application through the CPU registers.



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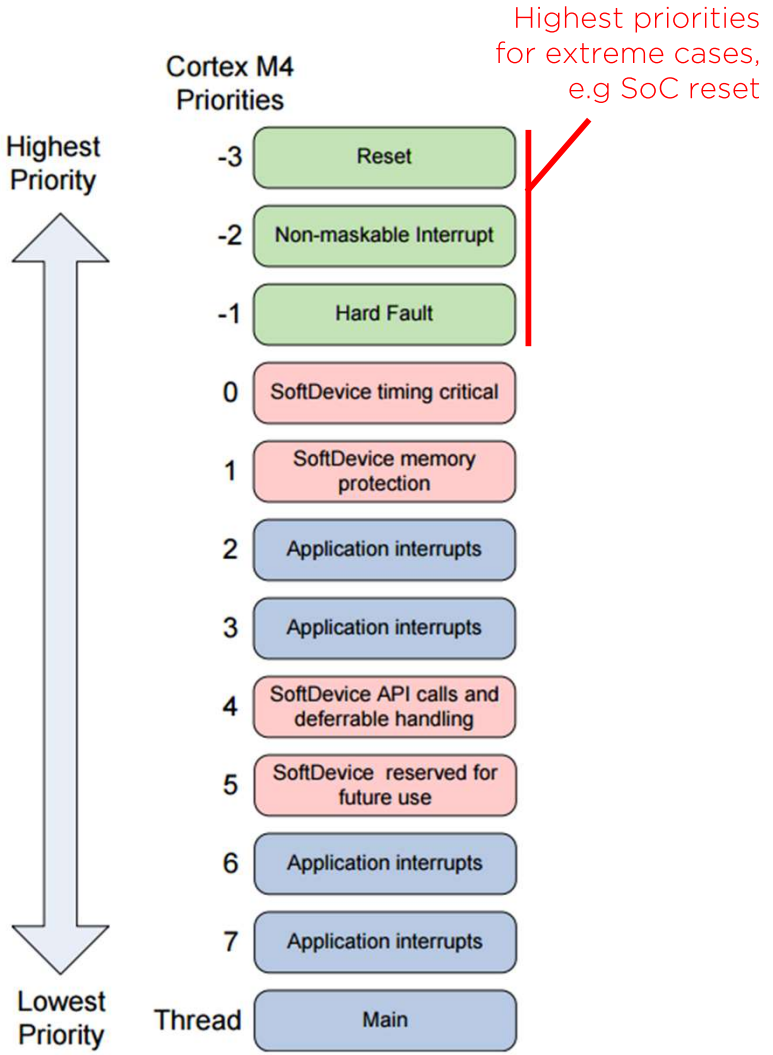
# SoftDevice @ Run-time

- SoftDevice processing is interrupt driven
  - Access to CPU must be shared between application and SoftDevice interrupts
- Cortex M4F has 8 interrupt priorities and main context
- The SoftDevice uses 4 priorities:
  - Level 0 - timing critical processing
  - Level 1 – handling memory isolation and run time protection
  - Level 4 – higher level defferable tasks and SVC handling
  - Level 5 – reserved for future use
- The application has access to four 4 priorities and main context:
  - Level 2+3 – For critical interrupts where low latency is required. Cannot call any SVC
  - Level 6 – For SoftDevice event handling and other interrupts
  - Level 7 – For other interrupts



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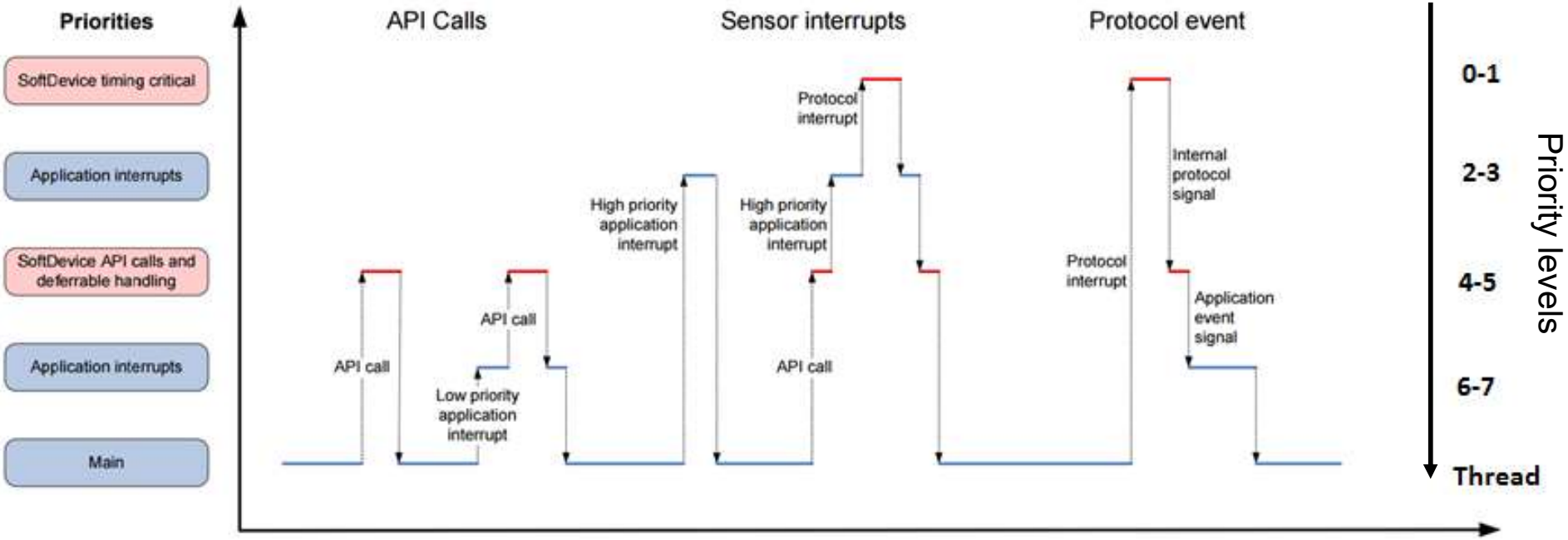
# SoftDevice Exception Examples




SoftDevice exception examples (some priority levels left out for clarity)

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# SoC Resource Requirements

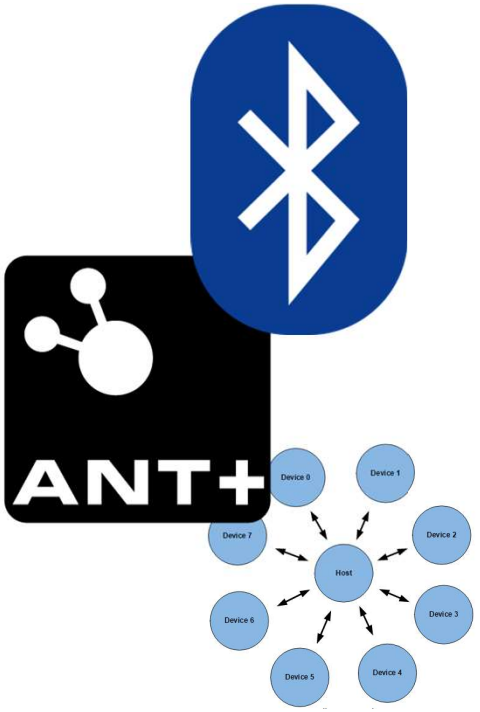
The SoftDevice restricts access to peripherals critical to stack.

- Restricted:
  - Clock
  - Random Number Generator
  - Temperature sensor
- Blocked:
  - Radio
  - RTC0
  - Software interrupts (SWI)

| ID | Base address | Instance | Access SoftDevice enabled | Access SoftDevice disabled |
|---|---|---|---|---|
| 0 | 0x40000000 | CLOCK | Restricted | Open |
| 0 | 0x40000000 | POWER | Restricted | Open |
| 0 | 0x40000000 | BPROT | Restricted | Open |
| 1 | 0x40001000 | RADIO | Blocked[6] | Open |
| 2 | 0x40002000 | UART0 / UARTE0 | Open | Open |

# Multi protocol support

- BLE, ANT, and Proprietary protocols can run concurrently.
- Radio timeslot API allows the application protocol to safely schedule radio usage between BLE events.
- The SoftDevice may be disabled and enabled at run-time.
- Can suppress SoftDevice radio activity
- Can be used for time critical peripheral operation.



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# S140 Bluetooth LE stack

Concurrent multi-link
Stack for Nordic nRF52 Series SoCs

Version 5.0.0 released June 2017
Bluetooth 5 Qualified Production Release

## Key Features:

- Bluetooth 5 certified
- Complete stack up to and including GATT/GAP
- Production tested pre-compiled binary
- Event-driven, thread safe GATT/GAP APIs
- Peripheral, Central, Broadcaster and Observer roles
- Concurrent multi-role
- Up to 20 concurrent links
- Over-the-air DFU
- Support for LE Secure Connections
- Support for external PA/LNA
- Support for configurable per connection Long ATT MTU
- Support for Data Packet Length Extension and connection length extension (>6 packets per event)
- Support for Privacy 1.2, LE Ping
- Flexible RAM scheme
- L2CAP Connection oriented channels
- 2Mbps and Long Range BLE PHY support
- Channel selection algorithm #2 (better BLE coexistence)


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