



nRF9160 SiP: Optimized for ultra low power

Using the nRF9160 SiP

As a Serial LTE Modem

Webinar

Nordic Semiconductor

November 2020

Duration 60 min

Today's host

Joakim Andre Tønnesen

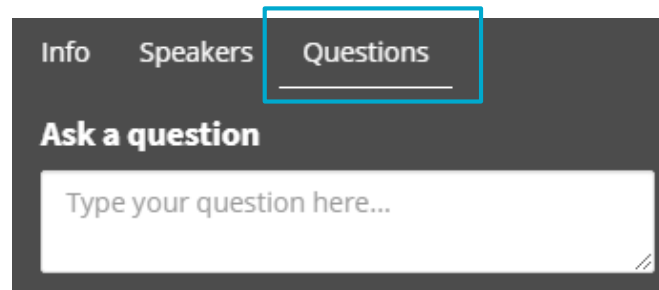


Technical Product Manager
Cellular IoT



Practicalities

- Duration: 45 mins
- Questions are encouraged!
- Please type your question in the Questions tab on the right sidebar
- All questions are anonymous
- We will answer questions towards the end
- All questions will be answered in a written Q&A shared a few days after the webinar
- Please use DevZone if you have further questions



{ DevZone

Content

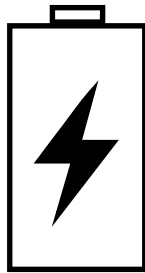
- nRF9160 SiP overview
- Development tools
- nRF Connect SDK
- The Serial LTE Modem
- Q&A

nRF9160 SiP Overview

Low power LTE-M and NB-IoT

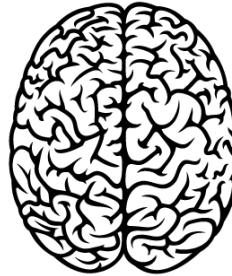
The nRF9160 Advantage in cellular IoT

Low Power



Build everything from scratch for low power
Integrate memories and use low-leakage process features

Ease of Use



Enable self-service for thousands of customers and hundreds of applications

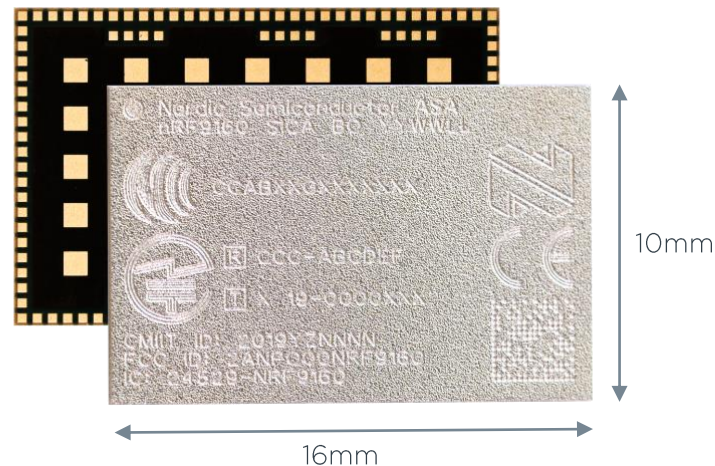
Integration



Integrate and use advanced packaging techniques to reduce solution size

nRF9160 – voids cellular modules

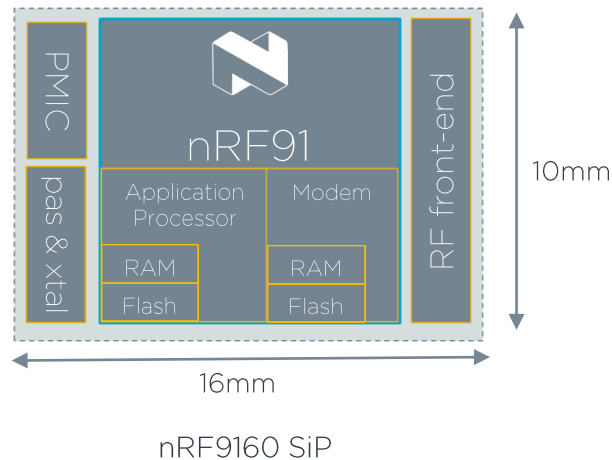
- Based on Nordic Dual Core SoC:
 - multiband LTE-M/NB-IoT modem with GPS
 - ARM Cortex M33 MCU for the application
- Small form factor (includes PMIC, RF FEM, passives and crystals)
- Ultra Low Power – 19uA @ 81.92s eDRX
- Multiband support for global coverage
- Pre-certified System-in-Package (SiP)



nRF9160 SiP

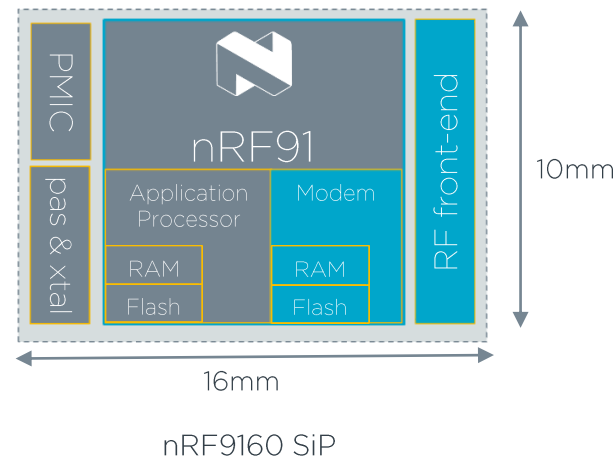
nRF9160 – voids cellular modules

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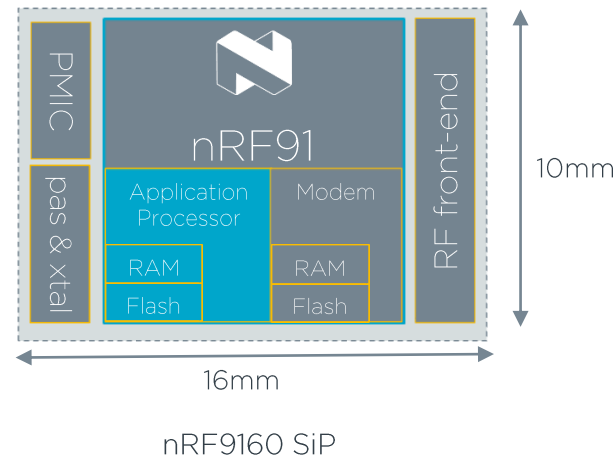
nRF9160 – low power LTE-M/NB-IoT modem

- LTE-M and NB-IoT modem
- World-wide operation
- Built from scratch for low power
- Support eDRX and PSM power saving
- GPS
- IPv4/IPv6, TCP/UDP, TLS/DTLS
- 50Ω antenna pin interface
- Supports any SIM or eSIM

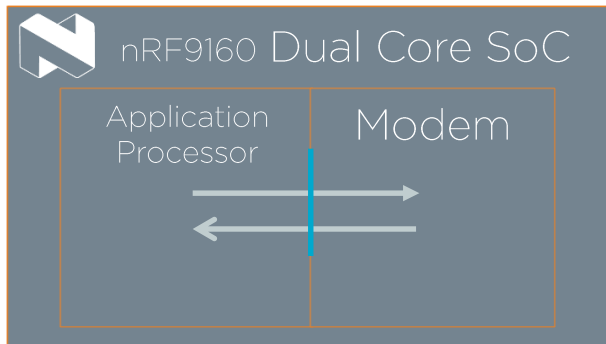


nRF9160 – application processor

- 64 MHz Arm® Cortex® -M33 CPU
- Arm TrustZone® to prevent over-the-air attacks
- Arm CryptoCell® 310 for application-level security
- 1 MB flash, 256 kB RAM
- 4x(SPI/UART/I2C), PDM, I2S, PWM, 12-bit ADC
- 32 GPIO

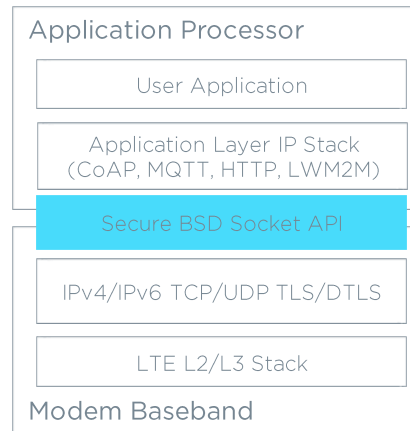


The benefits of dual core



Dual Core: Seamless interaction

- Dedicated resources for each core
- Modem is abstracted for simple integration
- Seamless interaction Modem – MCU
- Tight Integration – efficient data and control transfer

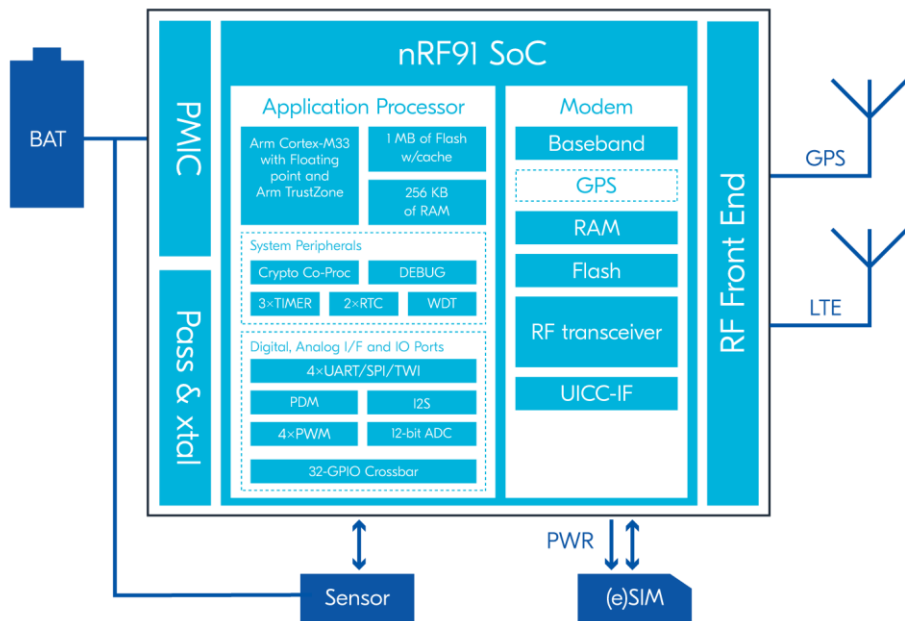


Dual Core: Flexibility in protocols

- All major protocols supported and more to come
- LWM2M / CoAP / MQTT on application processor: customers free to customize
- Ideal to support all Device Management platforms

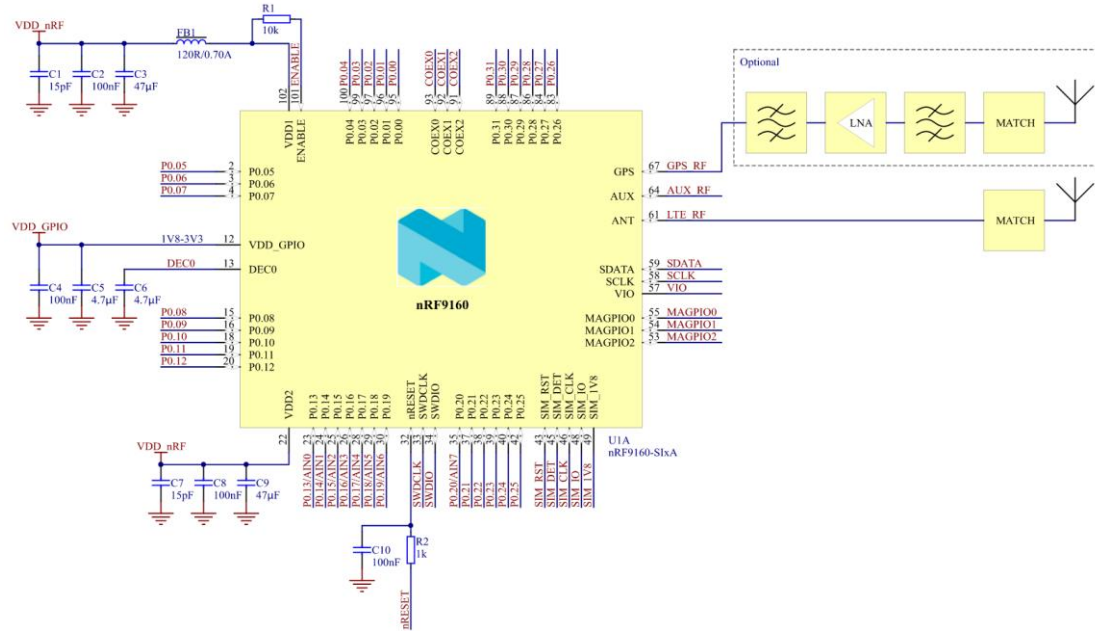
nRF9160 Application Circuit

The SiP Approach



- Low power
- Small size
- Simple BOM
- Your application runs inside the SiP
- Nordic provides the SDK with embedded RTOS and Free Toolchain

Hardware: simple integration and design



- Decoupling caps
- One inductor
- Two pull resistors
- LTE antenna matching
- (Optional) GPS

Development tools

For Cellular IoT

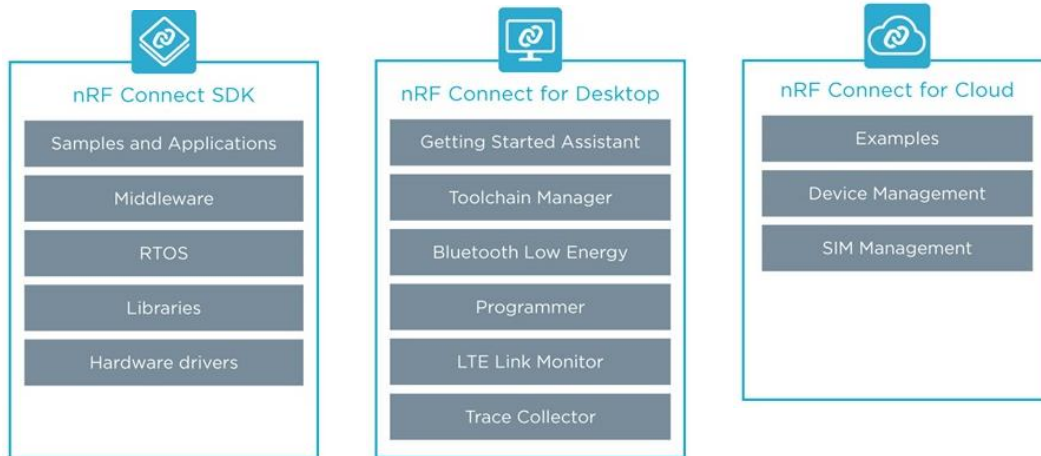
nRF9160 Development Tools

Development Kits



Out-of-the-box cloud connectivity

Nordic nRF Connect Suite

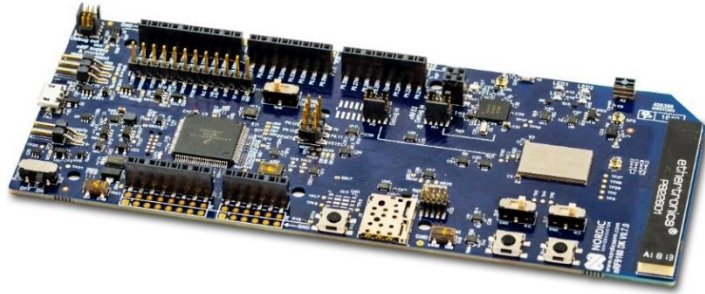


Open Source

IDE and Compiler

Cloud Connectivity

Nordic cellular IoT Kit Overview



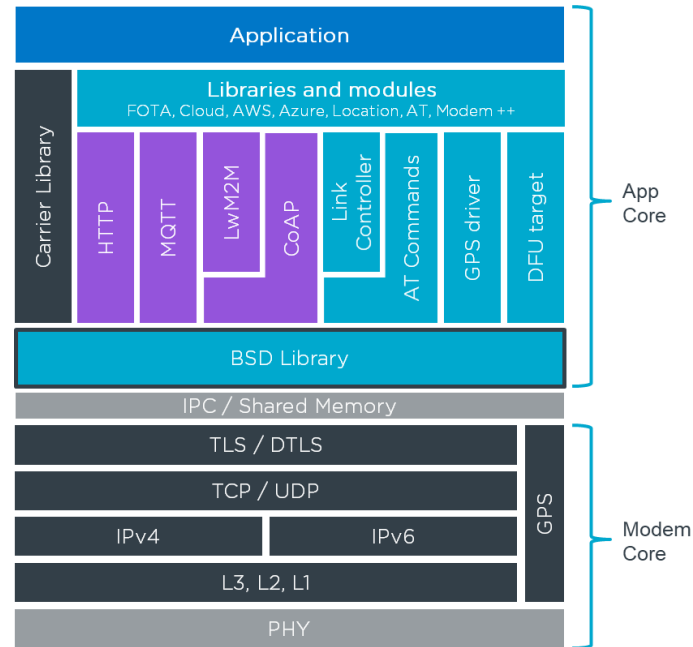
- Nordic Thingy:91
 - Battery Powered
 - Size Optimized
 - Modem and application programming over USB
 - Comes with iBasis SIM card and 20MB of data
- nRF9160 Development Kit
 - Mains powered and expansion headers
 - Include on-chip debugger w/ USB connection
 - Comes with iBasis SIM card and 20MB of data

nRF Connect SDK

Components relevant for Cellular IoT

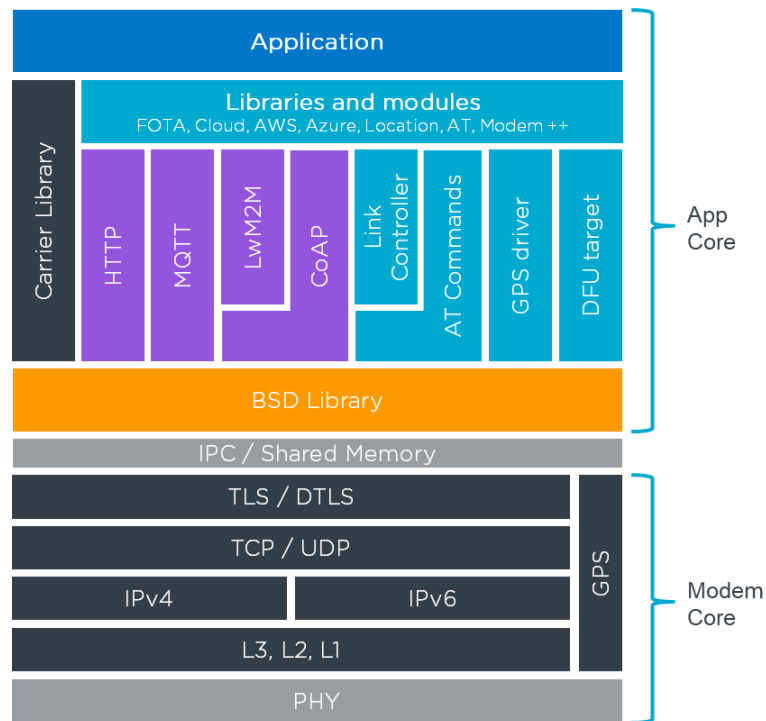
The nRF9160 Software Product

nRF Connect SDK



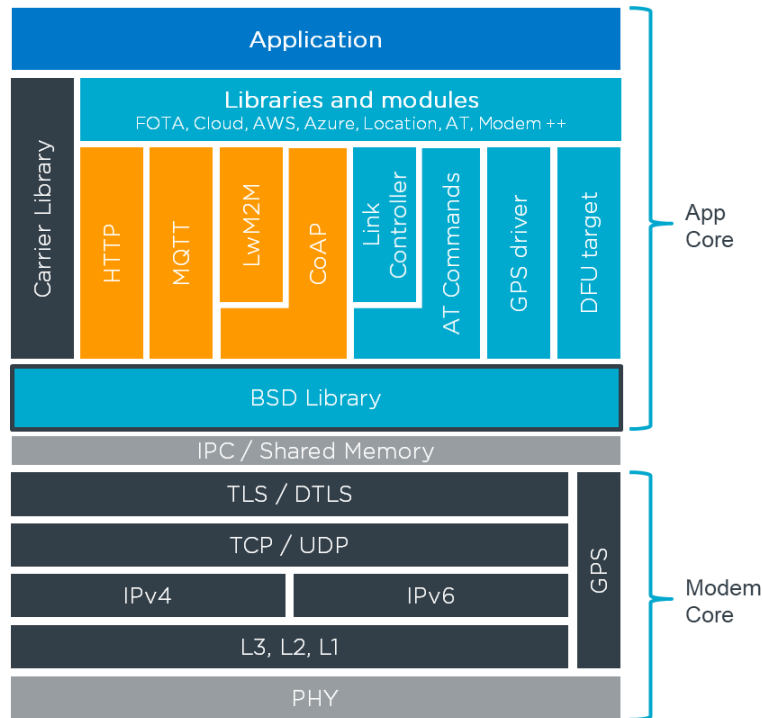
BSD Socket API

- Interface for operating the modem.
- 8 generic sockets.
 - UDP, TCP, TLS, DTLS and AT commands.
- 10 packet data network (PDN) sockets.
- GPS / Assisted GPS socket.
- Modem DFU socket.



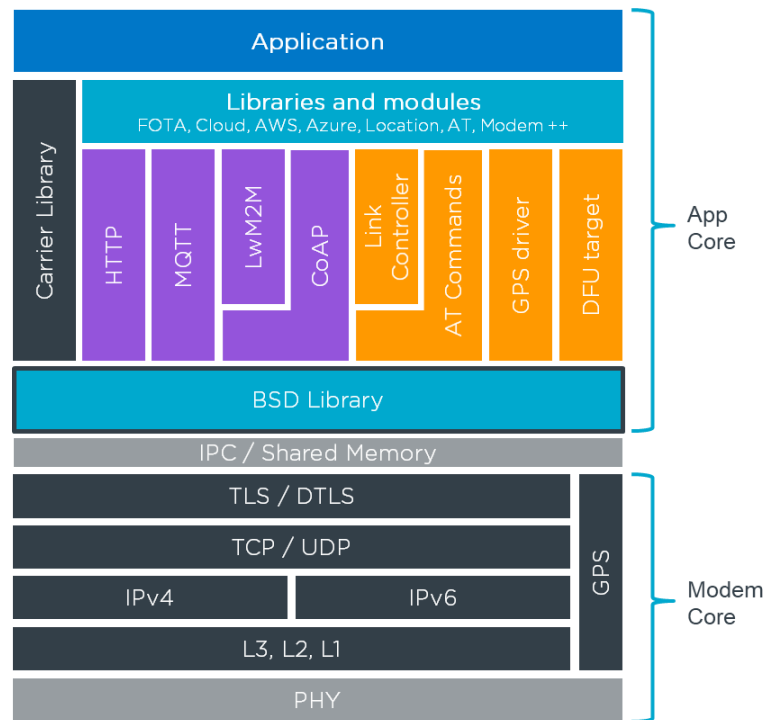
Internet Protocols

- Using TCP, UDP, TLS and DTLS generic sockets.
- Leverages code available in Zephyr RTOS
- Example usage in nRF Connect SDK
 - CoAP client
 - HTTPS client
 - LwM2M client
 - Simple MQTT
 - UDP
- Examples of direct socket usage available in Zephyr RTOS



Ease of use, utilities

- LTE Link controller
 - Provides an easy to use API to set up and configure the LTE link.
- AT commands
 - Libraries to handle AT command communication with the modem.
- GPS driver
 - Abstraction on top of the GPS socket.
- DFU target
 - Provides common interface for device firmware upgrade.
 - On top of the DFU socket.



nRF Connect SDK libraries

Cloud and internet connection

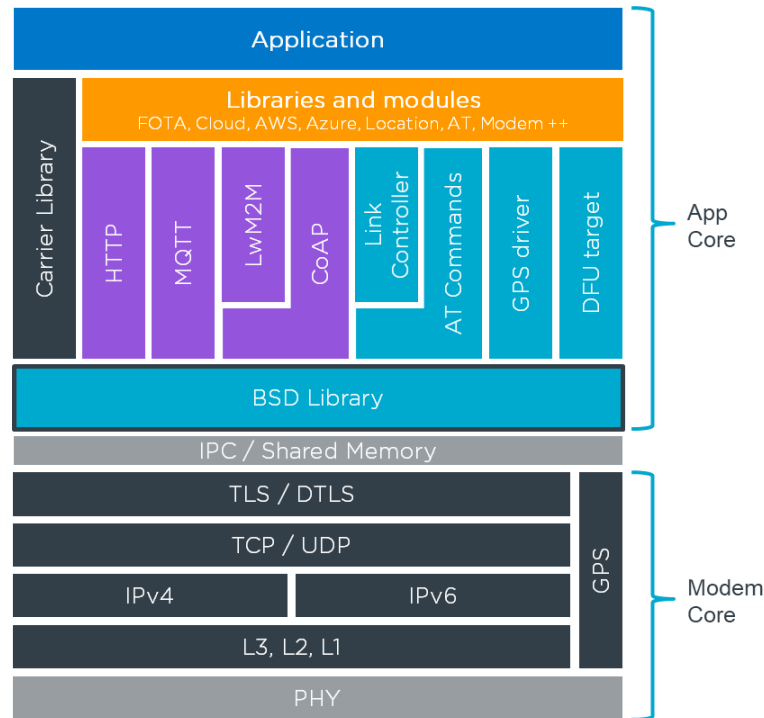
- nRF Connect for Cloud
- AWS FOTA, AWS IoT, AWS jobs
- Azure FOTA, Azure IoT Hub.
- Generic Cloud API
- CoAP utils
- Download client
- FOTA download

Location and GPS

- SUPL bases assisted GPS
- nRF Cloud assisted GPS

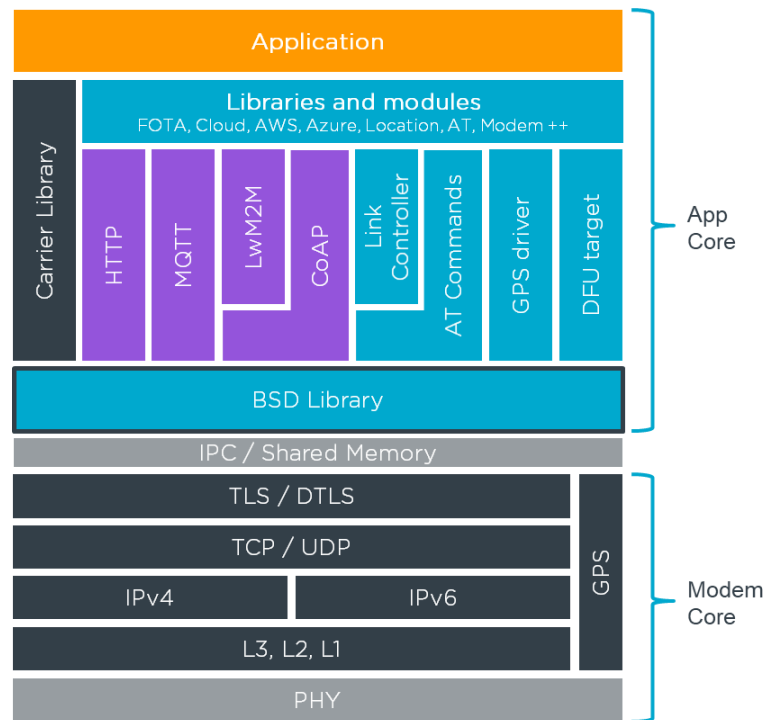
Modem

- Modem key / certificate management
- SMS subscriber



Applications and samples

- Asset Tracker
- Serial LTE modem, AT Client
- A-GPS, GPS sockets and SUPL client library
- AWS FOTA, AWS IoT
- Cloud client
- HTTP, MQTT, CoAP, LwM2M Clients
- Download client
- HTTP application update
- LTE Sensor Gateway
- LwM2M carrier
- Zephyr RTOS samples



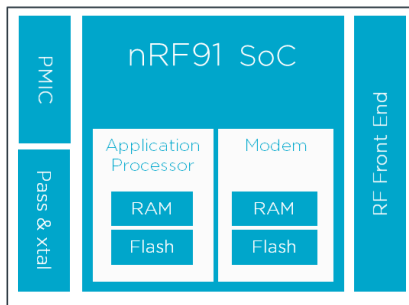
Saving power

Optimized HW and SW



Bottom up design from scratch
Low leakage processes
Optimizing radio performance

Smart application



Taking advantage of dual core,
optimizing the application:
when and what to send

Testing



Nordic help customers with
power measurement in different
scenario

Serial LTE Modem

Using nRF9160 as a stand-alone LTE Modem

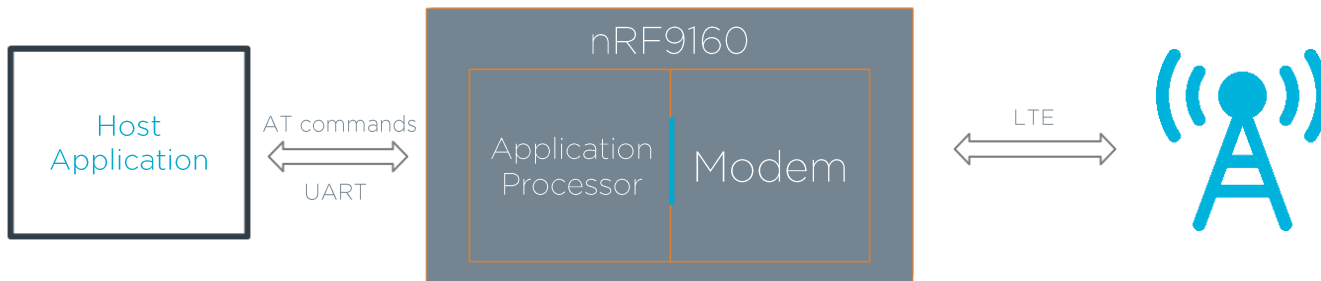
What is a Serial LTE Modem?

- Standalone LTE modem with a serial interface.
- Data and control using AT commands.



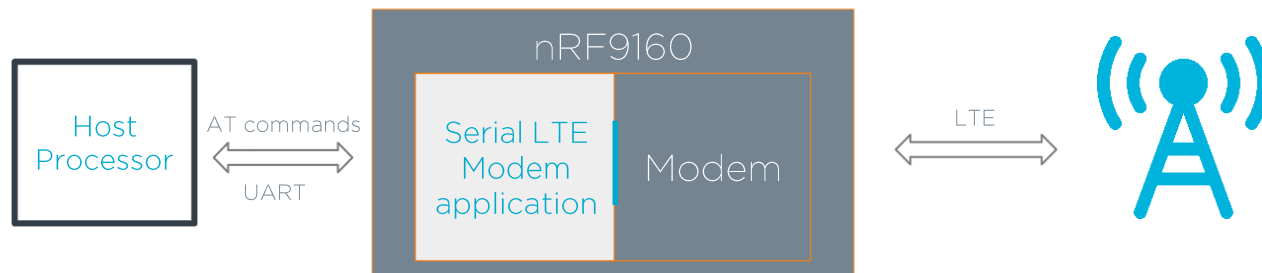
Using the nRF9160 as Serial LTE Modem

- When to use the nRF9160 as a serial LTE modem:
 - Quick modem evaluations
 - Keep existing application host and use nRF9160 as modem
 - Take your time and migrate host to nRF9160 application and save power and BOM



The nRF9160 Serial LTE Modem Approach

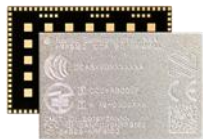
- *Serial LTE Modem* app running on the nRF9160 Application processor



- The *Serial LTE Modem* app is delivered as source code in nRF Connect SDK
 - Build and use as is
 - Customize and add functionality using the SDK
 - Nordic add AT commands and features on request

Getting started

Without compiling or writing firmware



Order a kit from your preferred distributor today

- Thingy:91 – battery powered and mobile
- nRF9160 DK – include debugger and expansion headers
 - *order a local SIM if you plan to use NB-IoT due to lack of roaming



Download and program the serial LTE modem application

- Latest application and modem firmware release zip from nordicsemi.com/nrf9160dk
- Download and use the nRF Connect for Desktop programmer to program the application
- [Programmer application documentation](#) found on Nordic infocenter



Open up a serial port and start sending AT commands.

- nRF Connect for Desktop LTE Link Monitor has a built in terminal for AT commands
- Serial LTE modem [AT command documentation](#) in the nRF Connect SDK documentation
- Modem [AT command documentation](#) found on Nordic infocenter

LTE Link Monitor

A nRF Connect for Desktop PC tool

The screenshot displays the LTE Link Monitor application interface. The top bar contains navigation options: a menu icon, 'Select device', 'Open logfile', 'Chart', 'Terminal', and 'Certificate manager'. The central terminal window shows the following AT command responses:

```

nRF9160-SICA CR LF
OK CR LF
AT+CGMR CR LF
mfw_nrf9160_1.2.2 CR LF
OK CR LF
AT+CEMODE? CR LF
+CEMODE: 2 CR LF
OK CR LF
AT+XCBAND=? CR LF
+XCBAND: (2,3,4,8,12,13,20,28) CR LF
OK CR LF
AT+CMEE? CR LF
+CMEE: 1 CR LF
  
```

Below the terminal is a text input field with the placeholder 'Type AT command here...'. To the right, there are three panels:

- Status Panel:** Features tabs for UART, Modem, UICC, LTE, and PDN. The LTE tab is active, showing:
 - Signal Strength:
 - Functionality: Normal
 - UICC: UICC init OK
 - Pin: no PIN required
 - Pin Retries: 3
 - Mode: CS/PS mode 2
 - Bands: 1-5,8,12-14,17-20,25-26,28,66
 - Current Band: N/A
- Network Search Panel:** Includes a 'Search networks' button.
- Registration Details Panel:** Displays the following information:

CID	Addr
Registration:	unknown
MccMnc:	N/A
Operator:	N/A
CellID:	4294967295
TAC:	65534

 At the bottom of this panel is a button labeled 'Show serving station location' with a location pin icon.

- [How to connect with the LTE Link Monitor](#) in nRF Connect SDK documentation
- [Full LTE Link monitor documentation](#) on Nordic infocenter.
- Very useful for sending and receiving AT commands

How to test?

- Examples in Serial LTE modem documentation
 - Reading and writing configurations
 - TCP / UDP client
 - TCP / UDP server
 - DNS lookup
 - ICMP
 - FTP client
 - GPS

nRF Connect SDK
1.4.99

CONTENTS:

[About the nRF Connect SDK](#)
[About this documentation](#)
[Getting started](#)
[Development model](#)
[Application development](#)
[Working with nRF91 Series](#)
[Working with nRF53 Series](#)
[Working with nRF52 Series](#)
[Protocols](#)

Applications and samples

Applications

[nRF9160: Asset Tracker](#)
[Connectivity bridge](#)
[nRF Desktop](#)

nRF9160: Serial LTE modem

[Application description](#)
[Extending the application](#)
[AT commands](#)

[Samples](#)
[Tests](#)
[Drivers](#)
[Libraries](#)
[Scripts](#)
[Release notes](#)
[Known issues](#)

nRF Connect SDK 1.4.99

UDP client

1. Test a UDP client with connectionless UDP:

- a. Open a UDP socket and read information (handle, protocol, and role) about the open socket.

```

AT#XSCKET=1,2,0
#XSCKET: 1, 2, 0, 17
OK
AT#XSCKET?
#XSCKET: 1, 17, 0
OK
  
```

- b. Send plain text data to a UDP server on a specified port. Replace *example.com* with the host name or IPv4 address of a UDP server and 1234 with the corresponding port. Then retrieve the returned data.

```

AT#XSENDTO="example.com",1234,1,"Test UDP"
#XSENDTO: 0
OK
AT#XRECVFROM
PONG: Test UDP
#XRECVFROM: 1, 14
OK
  
```

- c. Send hexadecimal data to a UDP server on a specified port. Replace *example.com* with the host name or IPv4 address of a UDP server and 1234 with the corresponding port. Then retrieve the returned data.

```

AT#XSENDTO="example.com",1234,0,"DEADBEEF"
#XSENDTO: 4
OK
AT#XRECVFROM
504F4E473A20DEADBEEF
#XRECVFROM: 0, 20
OK
  
```

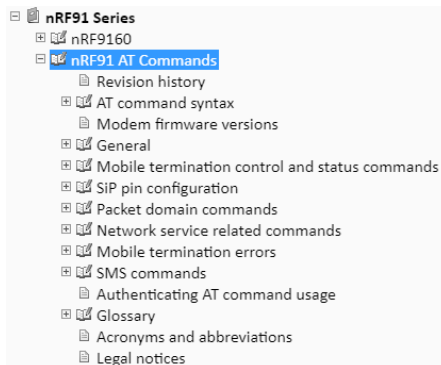
- d. Close the socket.

```

AT#XSOCKET=0
#XSOCKET: 0, closed
OK
  
```

More AT commands!

- Serial LTE modem application
 - AT commands for using sockets and middleware protocols
 - Found in the nRF Connect SDK documentation
- Modem firmware
 - Standard AT commands to control the modem and link
 - Found on infocenter.nordicsemi.com

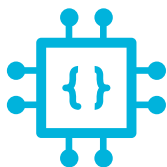


Customizing the application



Download and install nRF Connect SDK and the toolchain

- Through nRF Connect for Desktop [Toolchain Manager](#)
- Or [manual installation guide](#) in nRF Connect SDK documentation



Customize, compile and program the application

- Source code found under ncs/nrf/applications/serial_lte_modem
- [Extending the application chapter](#) in the serial LTE modem documentation
- Documentation for [modifying](#), [compiling](#) and [testing](#) sample applications



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Q&A