



nRF9160 SiP: Optimized for ultra low power

nRF9160 overview

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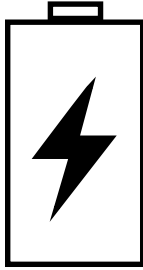
Webinar Practicalities



- Duration: 50-60 minutes
- Questions are encouraged !
- Please type questions in the top right sidebar
 - All questions are anonymous
 - Keep them relevant for the topics
 - The chat is not anonymous, and should not be used for questions
- We answer questions at the end
- For more questions use {DevZone

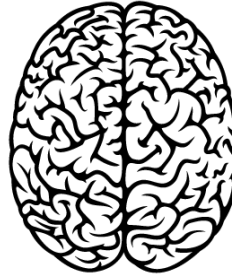
The nRF9160 Advantage in cellular IoT

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

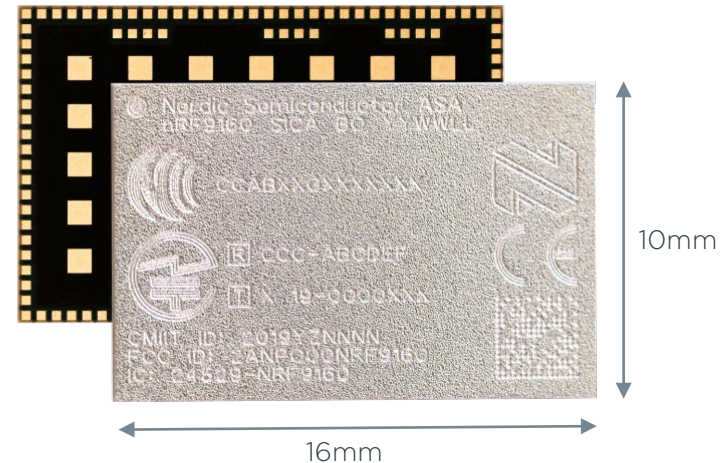
Integration



Integrate and use advanced packaging techniques to reduce solution size

nRF9160 – voids cellular modules

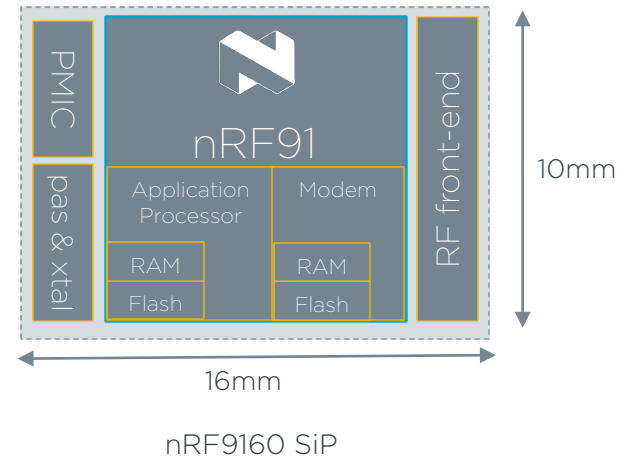
- Based on Nordic Dual Core SoC:
 - multiband LTE-M/NB-IoT modem with GPS
 - ARM Cortex M33 MCU for the application
- **Small** form factor (includes PMIC, RF FEM, passives and crystals)
- **Ultra Low Power** – 19uA @ 81.92s eDRX
- Multiband support for global coverage
- **Pre-certified** System-in-Package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



nRF9160 SiP

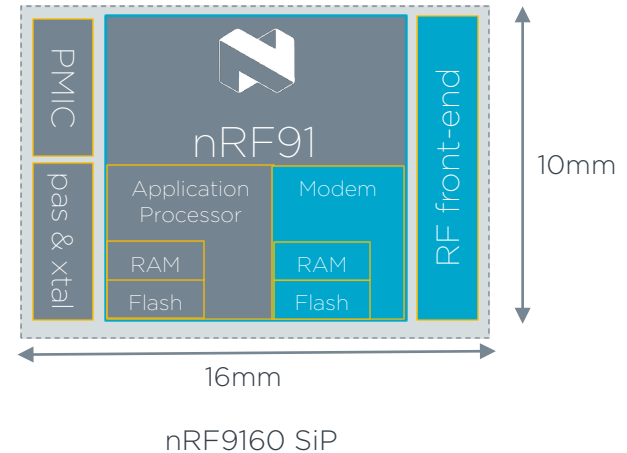
nRF9160 – voids cellular modules

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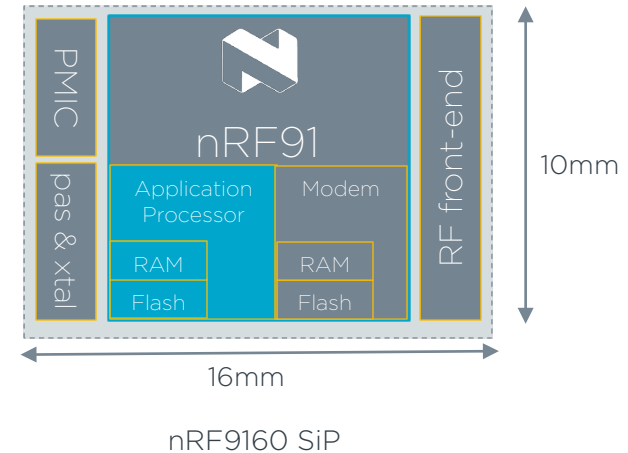
nRF9160 – low power LTE-M/NB-IoT modem

- 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

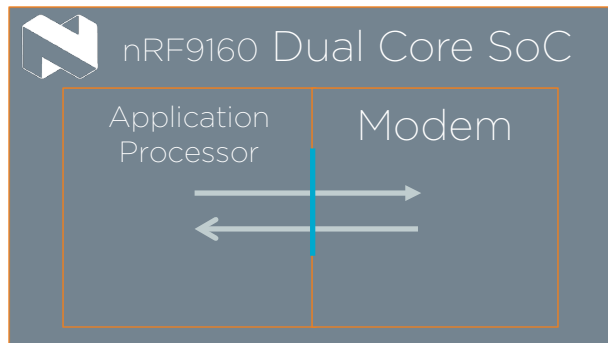


nRF9160 – application processor

- 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, ADC
- 32 GPIO

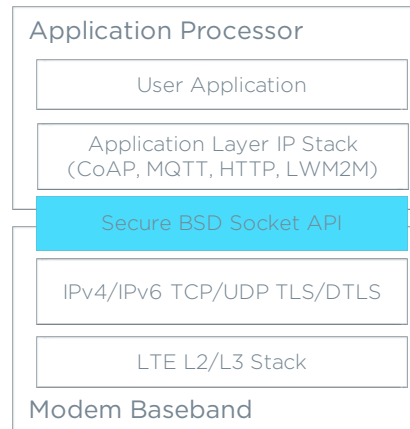


The benefits of dual core



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



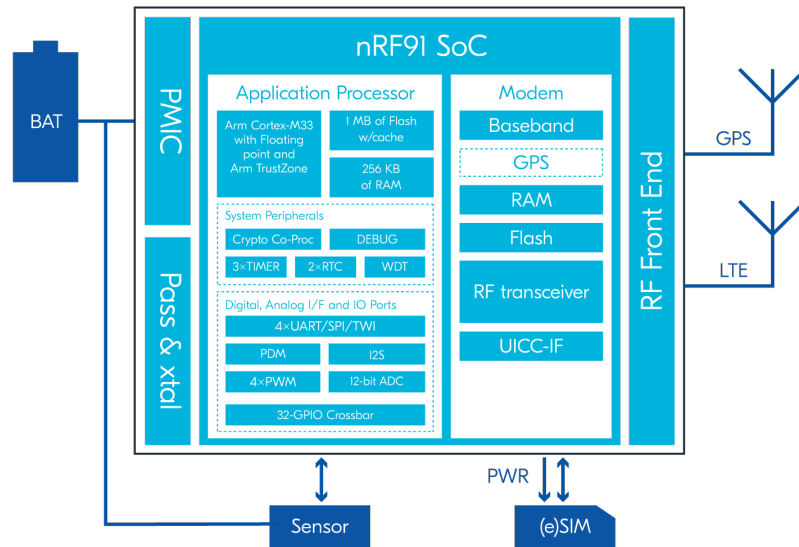
Dual Core: Flexibility in protocols

- 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

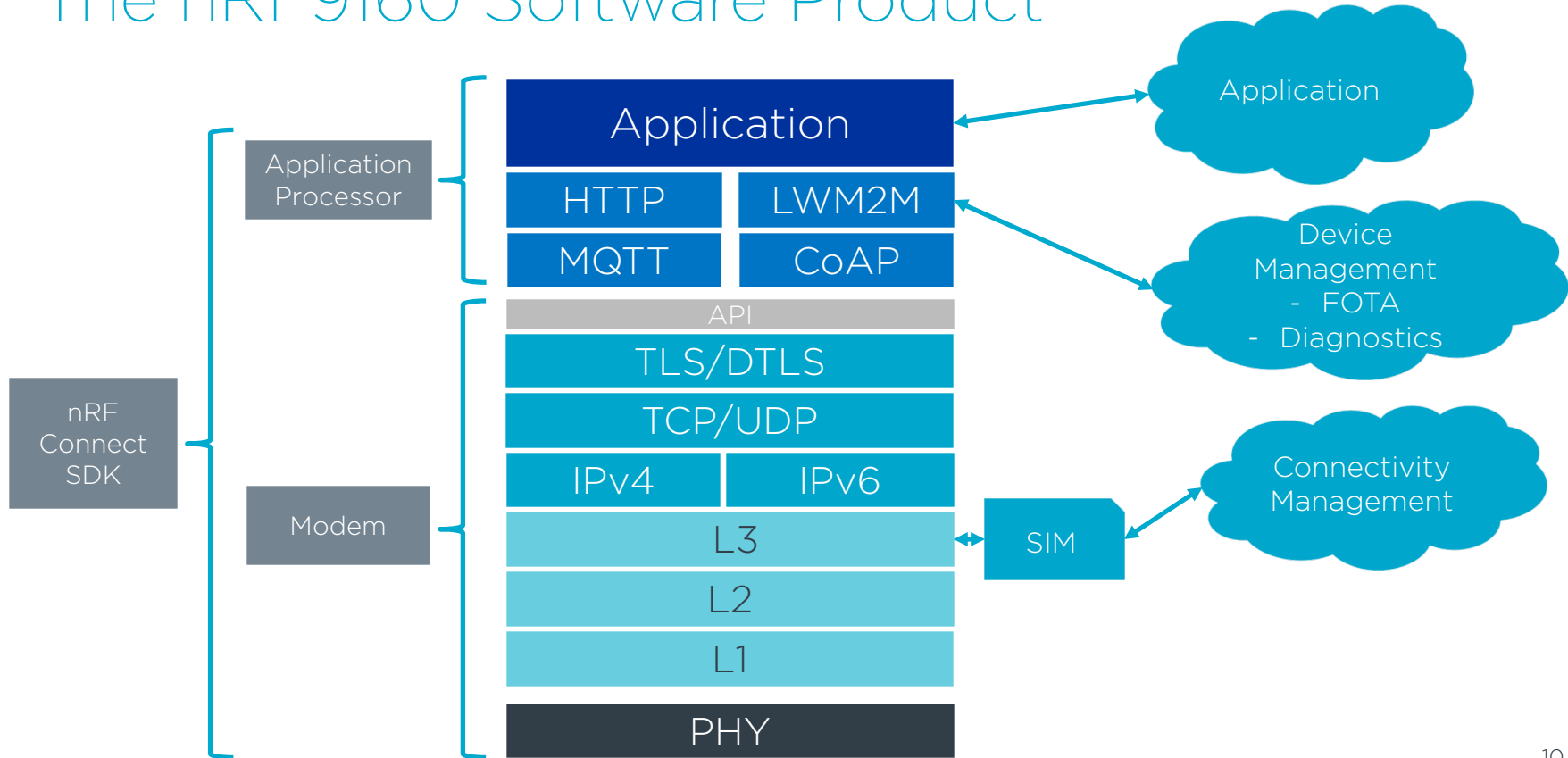
nRF9160 Application Circuit

The SiP Approach

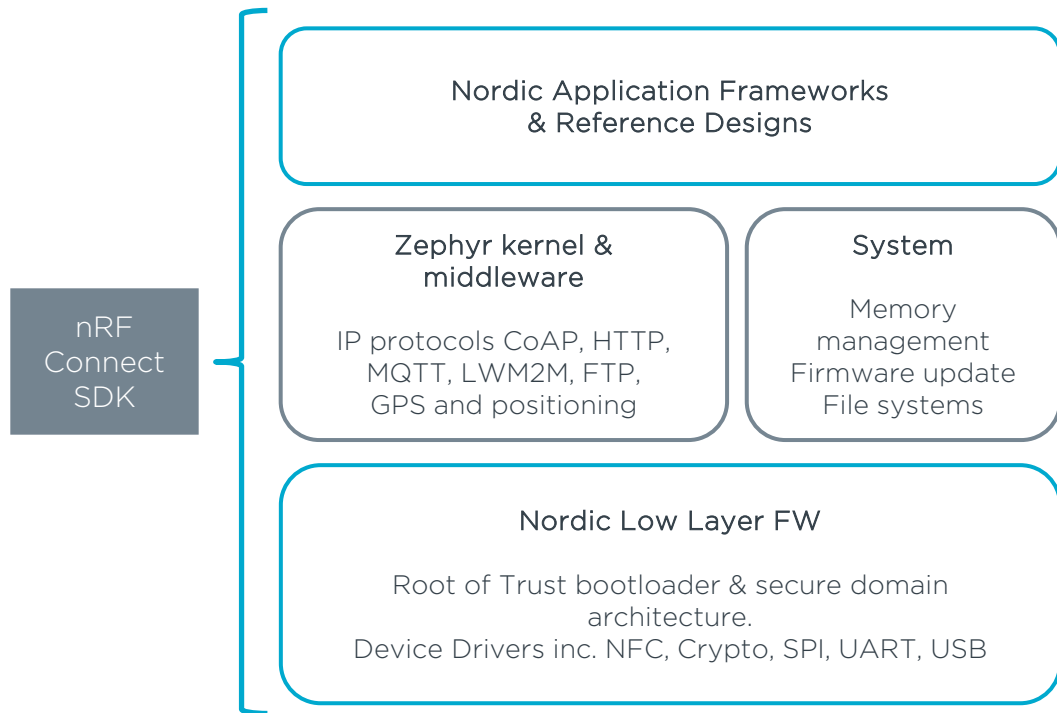
- Low power
- Small size
- Simple BOM
- Your application runs inside the SiP
- Nordic provides SDK with embedded RTOS and Free Toolchain



The nRF9160 Software Product

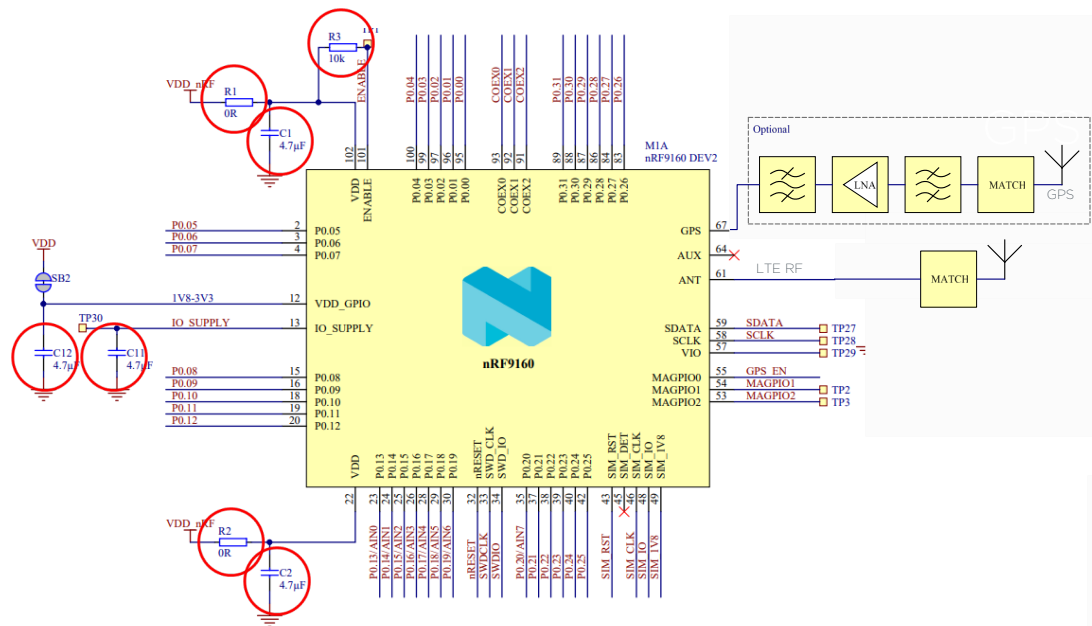


The nRF Connect SDK



- The SDK for the nRF9160
 - Free and open source
 - Continuously developed and improved
 - Lifetime support
- Integrates the Zephyr RTOS
- Publicly hosted on GitHub
 - version control management with Git

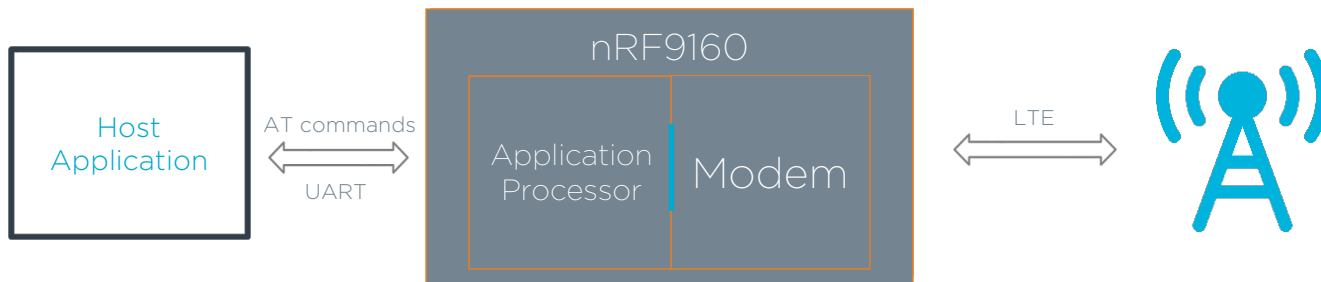
Hardware: simple integration and design



- 4x Capacitors
- 3x Resistors
- LTE antenna matching
- (Optional) GPS

Using the nRF9160 as Serial LTE Modem

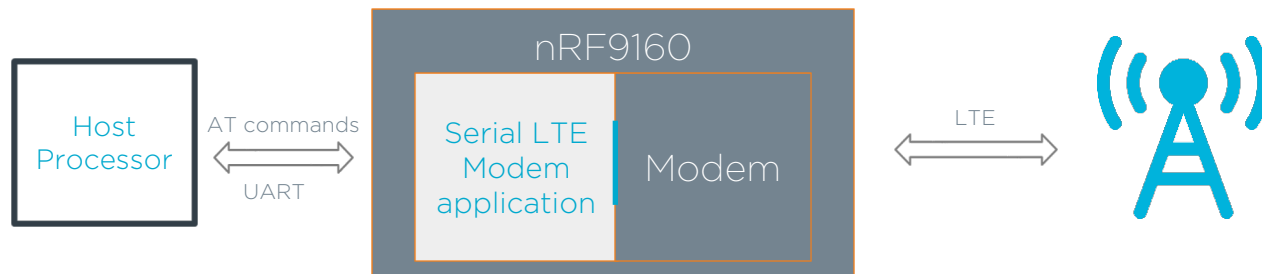
- Connect and control over USART using standard AT Command set



- 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

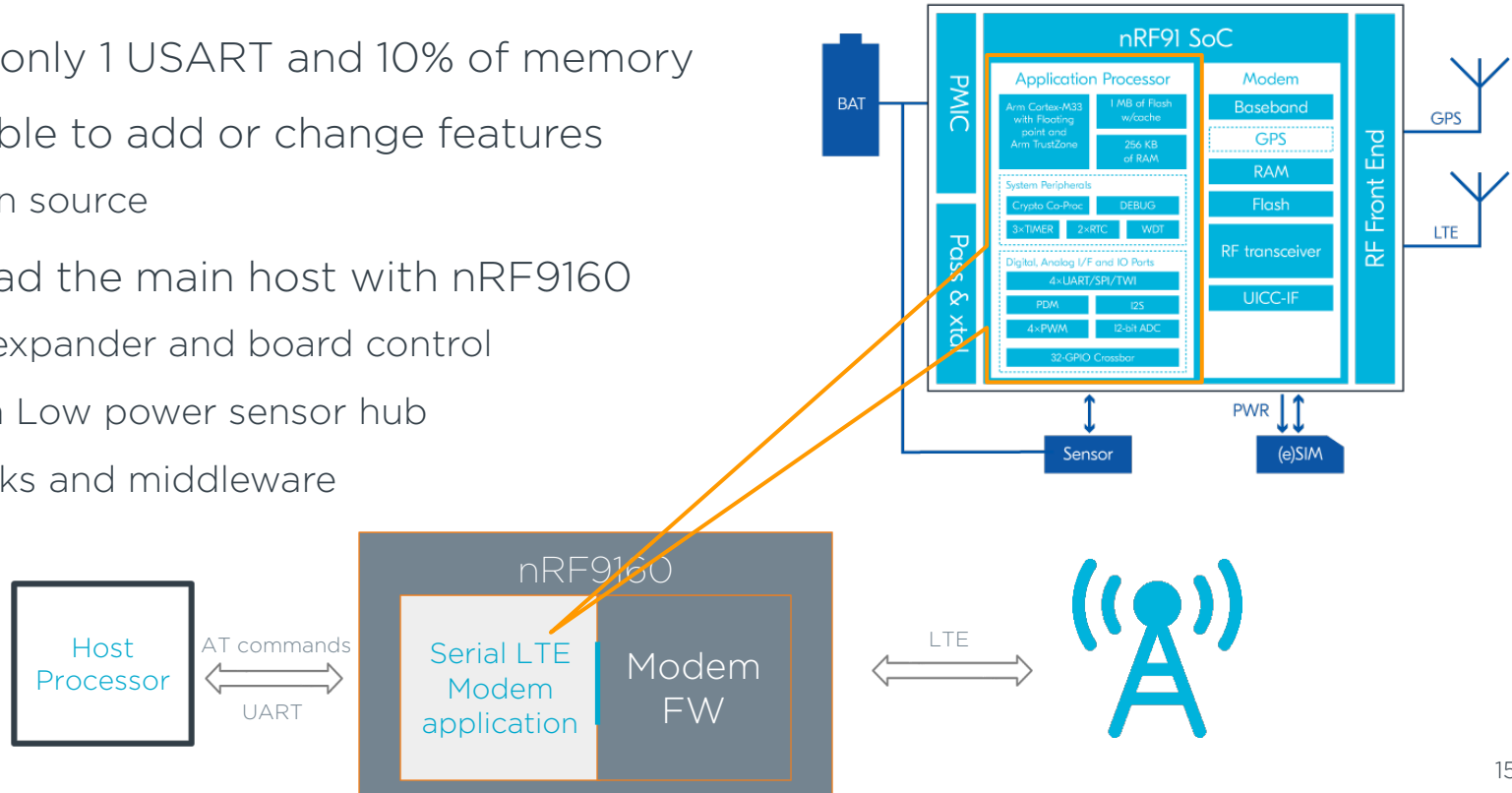
- *Serial LTE Modem* app running on the nRF9160 Application processor



- 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

Serial LTE Modem Application

- Uses only 1 USART and 10% of memory
- Possible to add or change features
 - Open source
- Offload the main host with nRF9160
 - I/O expander and board control
 - Ultra Low power sensor hub
 - Stacks and middleware



nRF9160 GPS and Positioning

nRF9160 - GPS and Location Services

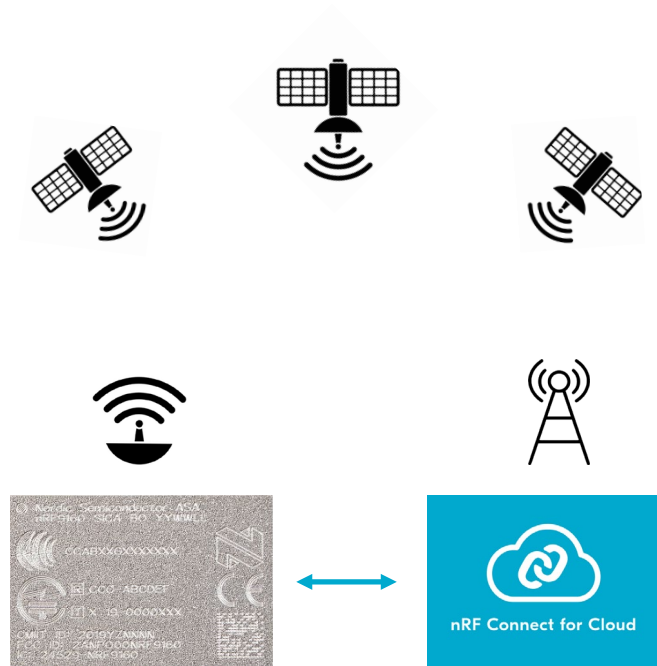
Optimized for constrained and embedded devices

■ Cloud Assisted GPS

- Time-to-first-fix from 30s -> 5s
- Data processed and packed in nRF Cloud
 - Saves power and data cost
- Normal assistance
 - ~2kB size: valid for 4 hours
- Predicted assistance coming in Q3-2020
 - TBD KB valid for 7-14 days

■ Recent GPS Enhancements

- Higher Sensitivity and lowered power



GPS Sensitivity and Power Enhancements

Modem Firmware Version 1.2

| | Firmware V1.1 | Firmware V1.2 |
|---------------------------------|---------------|---------------|
| Sensitivity, cold start | -143 dBm | -145.5 dBm |
| Sensitivity, hot start | -147 dBm | -147 dBm |
| Sensitivity, tracking | -152 dBm | -155 dBm |
| Power consumption, acquisitions | 42 mA | 40 mA |
| Power consumption, tracking | 47 mA | 45 mA |
| Power consumption, duty cycling | 10.1 mA | 9.8 mA |

nRF9160 Ultra Low Power

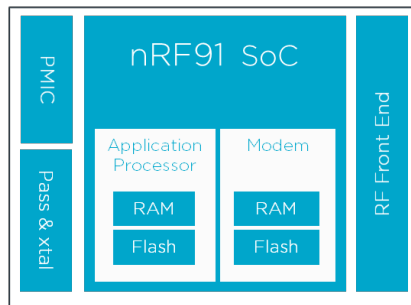
Saving power

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

nRF91 - Ultra Low Power

Key Data Points for the complete nRF9160 SiP

Sleep Current Consumption

| | | |
|-------------------------------|---------|---|
| System Off | 1.4 uA | MCU off w/ GPIO retention, modem off Wake-up from any GPIO, no RAM retention |
| PSM Floor | 4 uA | MCU and modem in sleep Wake-up from any GPIO and full retention Include SIM |
| PSM 1h cycle and T3324 to 20s | 12.8 uA | |
| eDRX Floor | 7uA | |

RRC Idle mode (LTE-M)

| | | |
|-----------------------------------|--------|--|
| eDRX Floor | 7uA | MCU and modem in sleep Wake-up from any GPIO and full retention |
| eDRX 81.92s, PTW and DRX 1.28s | 19uA | Include SIM |
| eDRX 655.36sm, PTW 10s, DRX 2.56s | 15.5uA | Include SIM |

nRF9160 – Ultra Low Power

Enables the lowest power cellular IoT solutions

| | Module A | Module B | Module C | Nordic nRF9160 | nRF9160 vs. closet module |
|---------------------------|--------------|--------------|---------------|----------------|---------------------------|
| PSM floor (retained) | ~30 uA | ~65uA | ~55 uA | 4 uA | -87 % |
| PSM event 'boot' | ~1100 mJ | N/A | ~700 mJ | 98.3 mJ | -86 % |
| 81.92s eDRX | ~50uA | ~1200 uA | ~6000 uA | 19 uA | -62 % |
| UL 180 kbps 23 dBm power | ~210 mA @B13 | ~175mA @ TBD | ~230 mA @B13* | 105 mA @ B13 | -40 % |
| Low Power Application MCU | No | No | No | Yes | |
| Embedded SDK | No | No | No | Yes | |

Significant nRF9160 power improvements to be announced soon

Utilize nRF9160 for Edge Computing

1. Radio transfers costs energy and subscription fee
2. Send information – not data
 - Data: Accelerometer data, continues 3x16-bit values every 100ms
 - Information: The thing fell over sideways hard and is now laying flat
– 1 byte of information at the event
3. When something interesting happens
 - send data anyway

Processing data:

~3 mA

3 ms

Sending data:

~150 mA

3 ms

NOW: First Online Power Profiler for Cellular

Estimate and optimize your nRF9160 power consumption

- Configure your settings
 - Network setup
 - Sleep intervals
 - Data payloads
- Visualized Power Profile
 - Peak current and timing
 - Average



Getting Started with Development

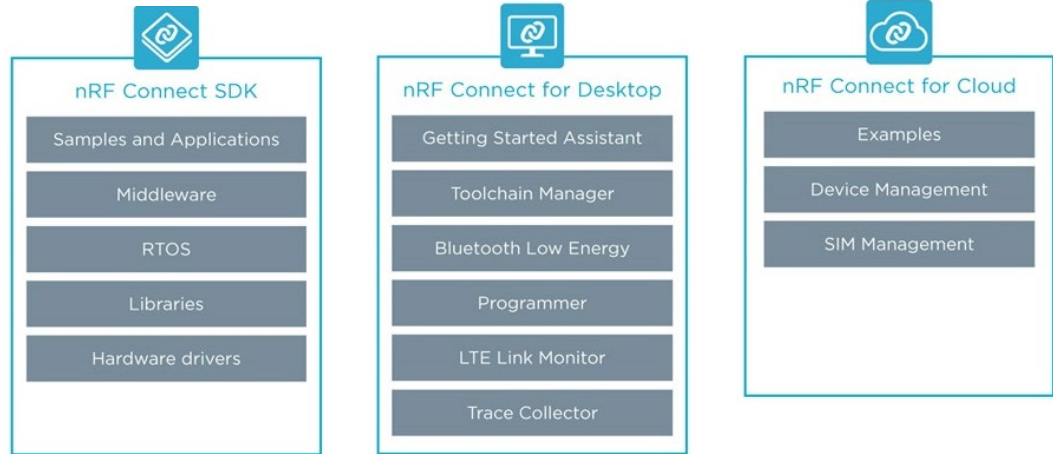
nRF9160 Development Tools

Development Kits



Out-of-the-box cloud connectivity

Nordic nRF Connect Suite

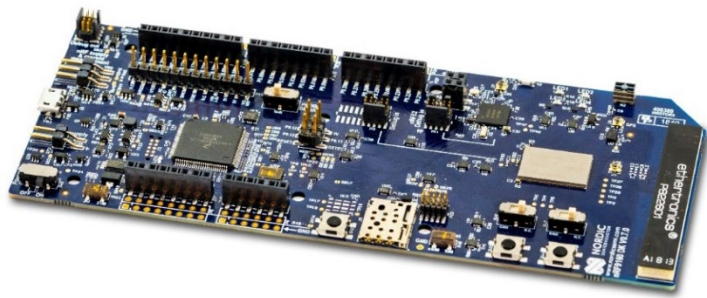


Open Source

IDE and Compiler

Cloud Connectivity

Nordic cellular IoT Kit Overview

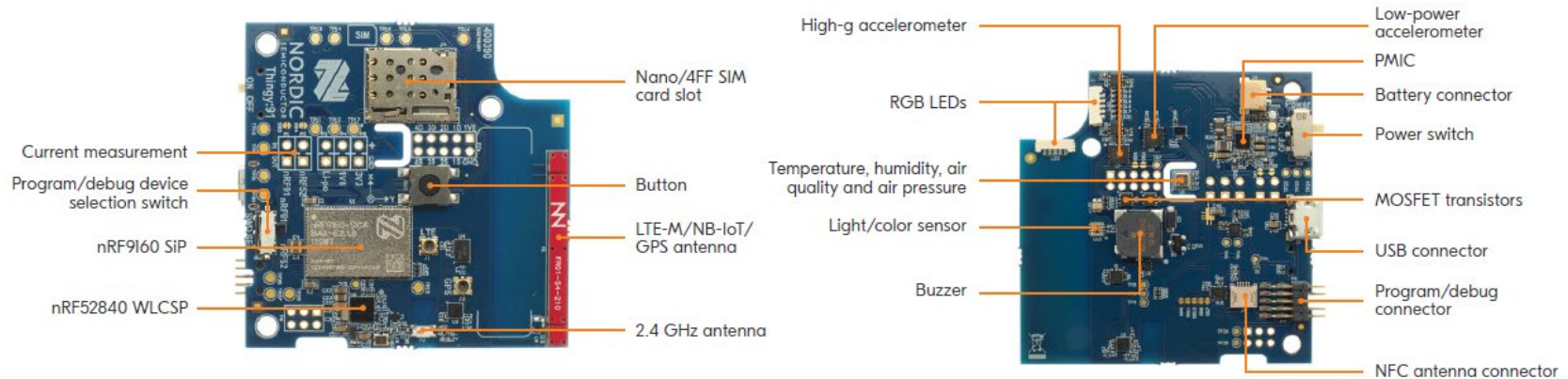


- Nordic Thingy:91
 - Battery Powered
 - Size Optimized
 - Modem and application programming over USB
 - Comes with iBasis SIM card and 20MB of data
- nRF9160 Development Kit
 - Mains powered and expansion headers
 - Include on-chip debugger w/ USB connection
 - Comes with iBasis SIM card and 20MB of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

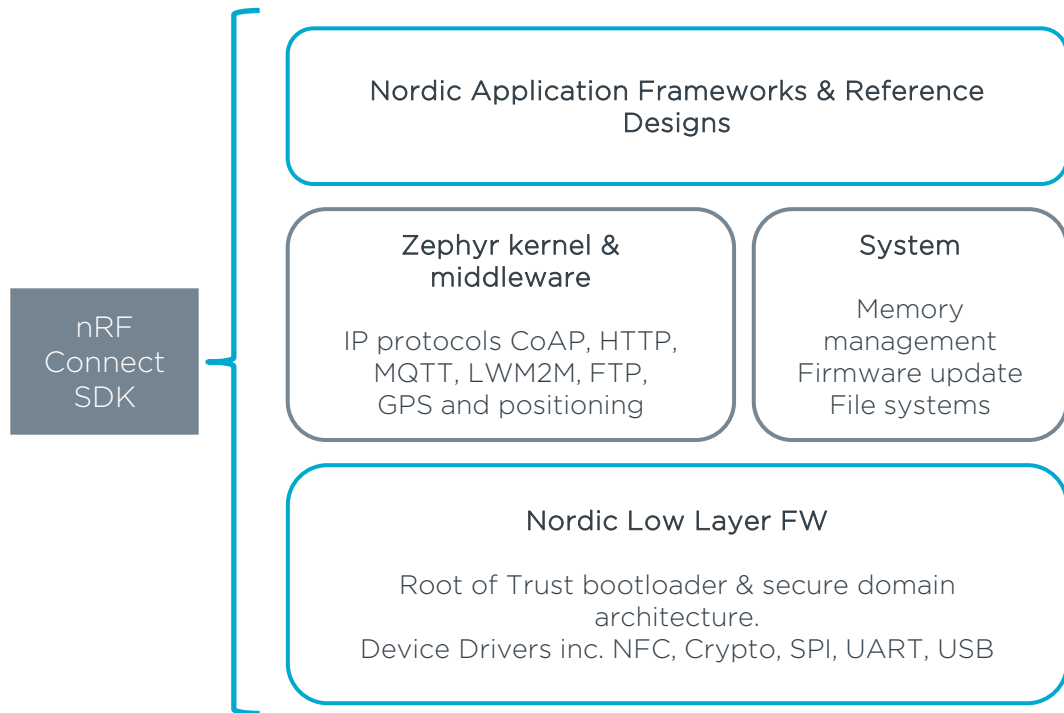
Nordic Thingy:91 Overview

Lowers the barrier for cellular IoT proof-of-concepts

- Fully available hardware design and open source software give
- Excellent starting point for your own designs
- Work with our antenna manufacturer on antenna design that fits your application !



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So How to Get Started ?



1. Order a kit from our 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



2. Create user account on nRF Connect for Cloud

- Unpack your kit and get connected - 8-step guide on nordicsemi.com/thingy91
- Configure and monitor your cellular device



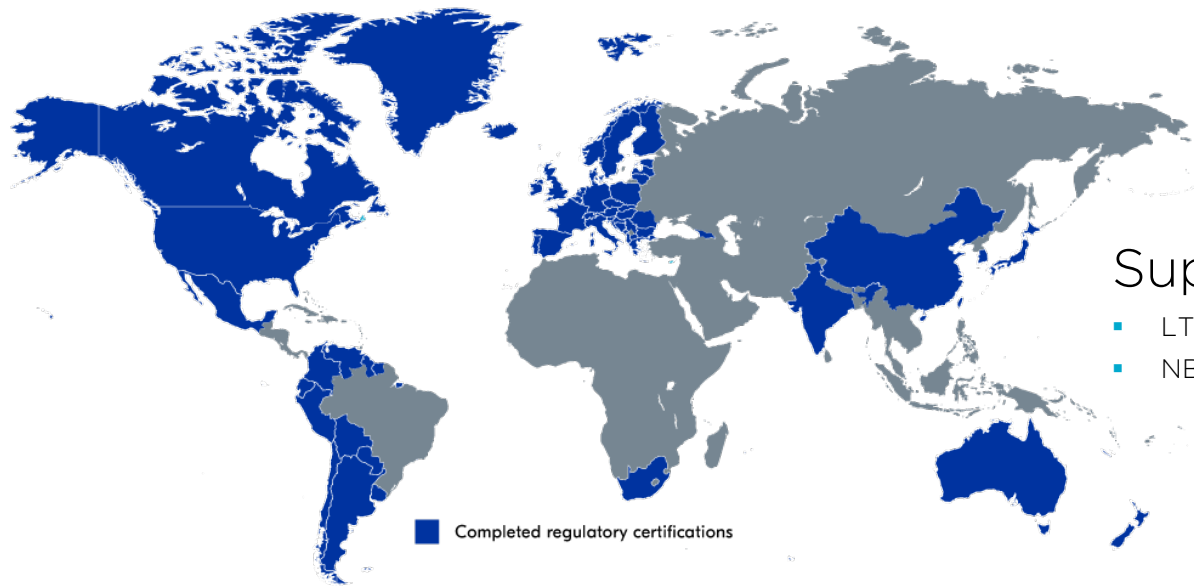
3. Download nRF Connect for Desktop w/the Getting Started Assistant

- Install the tool chain with compiler with IDE
- Install the nRF Connect SDK from GitHub

All set to dive into our getting started guides, videos and webinars.

nRF9160 Certification update

Leading worldwide coverage with single SKU



Supported LTE Bands:

- LTE-M: 1,2,3,4,5,8,12,13,14,17,18,19,20,25,26,28,66
- NB-IOT: 1,2,3,4,5,8,12,13,17,19,20,25,26,28,66

China Regulatory completed Q2-2020

Completed Carrier Certifications

| Carrier | Coverage | Protocol |
|------------------|----------------------|----------------|
| Verizon | USA | LTE-M |
| Vodafone | UK, Germany, NZ ... | NB-IoT |
| Deutsche Telekom | Germany, Austria ... | NB-IoT + LTE-M |
| Telstra | Australia | LTE-M |

- More in progress to double the list by end 2020



Nordic Cellular Expertise

2000+ Engineering years in Cellular !



- In-house unique expertise in Cellular
- 100+ World-renowned experts joined Nordic 4 years ago in Finland
 - Now 150+ eng. in Finland working on cellular
- Long experience in cellular
 - 2000+ Engineering years in Cellular
- Complemented by Nordic's low power DNA

