How to measure power consumption on the nRF9160 SiP

Nordic Tech Webinar

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Today’s host

Martin Lesund

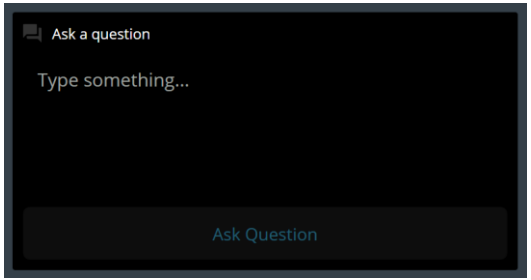
Technical Marketing Manager

Cellular IoT

NORDIC SEMICONDUCTOR

Practicalities

- Duration: 45 min presentation, 15 min Q&A
- Questions are encouraged!
  - Please type questions in the top of the right sidebar
  - All questions are anonymous
  - Try to keep them relevant to the topic
  - We will answer them towards the end
- The chat is not anonymous, and should not be used for questions
- Go to DevZone if you have more questions
- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com



{ DevZone

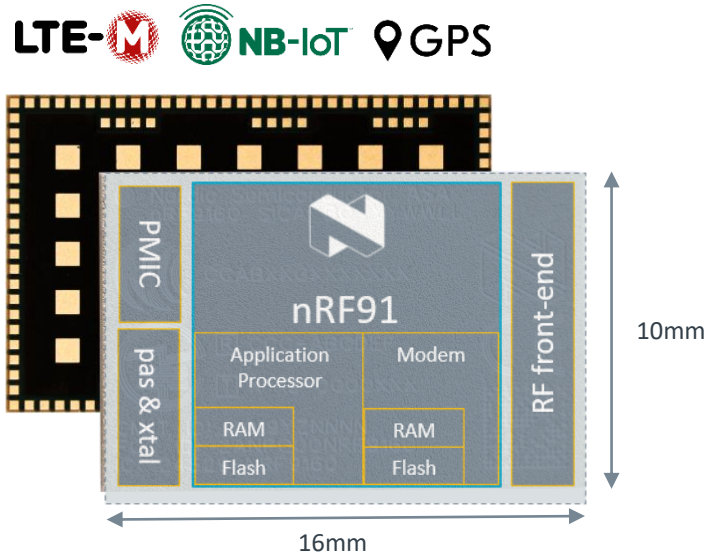
Agenda

- Introduction to nRF9160 SiP
- Different modes of the modem
- Different modes of the application processor
- Estimate power consumption using Online Power Profiler (OPP)
- Measure power consumption using Power Profiler Kit II (PPK2)
- How to optimize for low power
- Q&A

nRF9160 SiP introduction

nRF9160 – Voids Cellular Modules

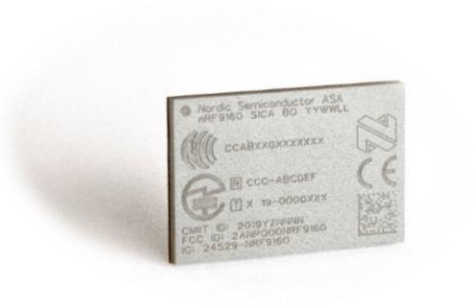
- Based on Nordic Dual Core SoC:
  - Arm® Cortex® M33 MCU for the application
  - Multiband LTE-M/NB-IoT modem with **GPS**
  - **Small** form factor (includes PMIC, RF FEM, passives and crystals)
  - **Ultra Low Power** – Avg. 18µA @ 81.92s eDRX
  - Multiband support for global coverage
  - Pre-certified System-in-Package (SiP)



nRF9160 SiP

nRF9160 SiP rev 2 - available now

- Improving an already best in class low power solution
- Significant nRF9160 power improvements introduced in **REV2**
- No changes on pin-out nor form factor
  - Existing REV1 designs only need to change an external cap *(DEC0) from 47µF to 4.7µF*



Description	nRF9160 REV2	Compared to REV1
CPU running CoreMark @64MHz from flash, HFXO + cache	2.2mA	-24%
PSM floor current	2.7µA	-33%
Avg. current eDRX *(655s, one PO/PTW, PTW=2,56s)*	6µA / 9µA [LTE-M / NB-IoT]	-33% / -18% [LTE-M / NB-IoT]

nRF9160 SiP – Ultra Low Power

Enables the lowest power for cellular IoT solutions

	Module A	Module B	Module C	Nordic nRF9160 GEN2	nRF9160 vs. closest module
PSM floor (retained)	~30 uA	~65uA	~55 uA	**2,7 µA**	**-91 %**
PSM event 'boot'	~1100 mJ	N/A	~700 mJ	**105 mJ**	**-85 %**
81.92s eDRX	~50uA	~1200 uA	~6000 uA	**18 uA**	**-64 %**
UL 180 kbps 23 dBm power	~210 mA @B13	~175mA @ TBD	~230 mA @B13*	**100 mA @ B13**	**-43 %**
Low Power Application MCU	No	No	No	**Yes**	***Only** on nRF9160*
Embedded SDK	No	No	No	**Yes**	***Only** on nRF9160*

Different Modes of the Modem

LTE Connection Modes

RRC Connected

Transfer user data

High power consumption

Synchronized with the network

RRC Idle

Listening to on the network

Sleep for shorter intervals to save power (eDRX)

Shorter DL latency

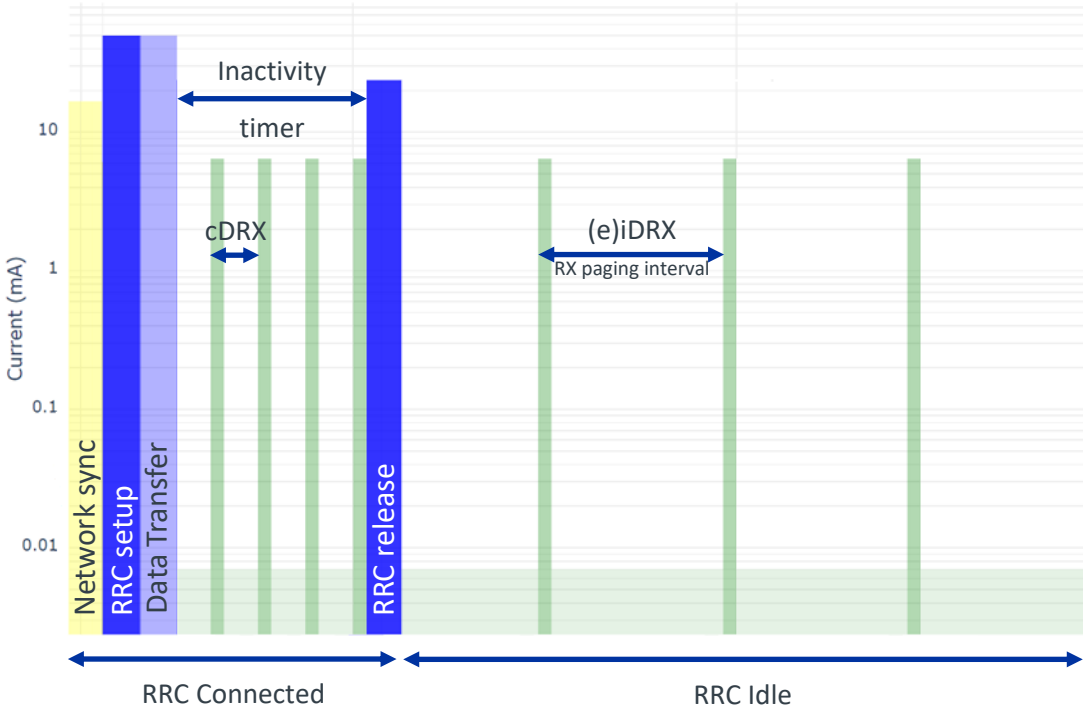
PSM

Sleep for longer intervals to save power

Longer DL latency

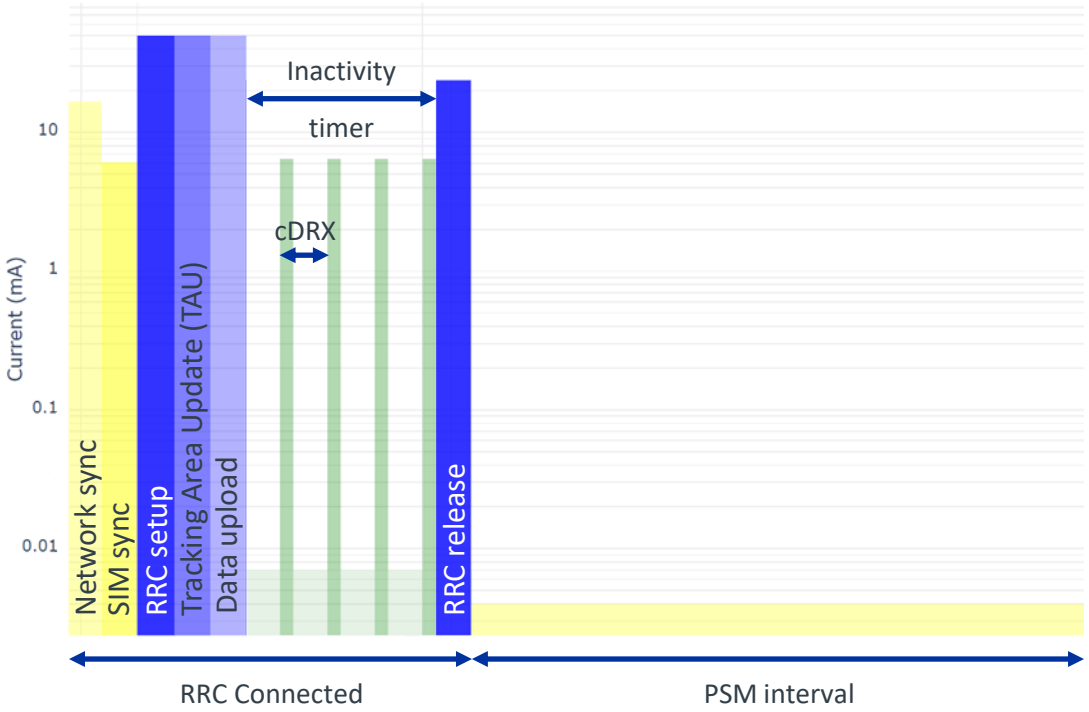
RRC Connected and RCC Idle

- Sleep in eDRX intervals to save power
  - cDRX: 0.01s to 10.24s
  - iDRX: 0.16s to ~44 min
  - We support all timers
- Device can wake up any time to send data
- Some network can store data for the device
- Device listens for data at the end of each DRX interval
- Longer DRX intervals results in longer downlink latency, but lower power



PSM

- Sleep in PSM intervals to save power
  - 10 min to 413 days
- Device can wake up at any time to send data
- After the end of each PSM interval, the modem switch back to RRC Connected
- Longer PSM intervals results in longer downlink latency, but lower avg. power consumption
- Lower floor current compared to iDRX intervals RRC Idle



Different Modes of the Application Processor

Application Processor Modes

- MCU will automatically switch to IDLE mode when it has no tasks to perform
- It operates separately from the Modem because of our dual core implementation

Description	Values
MCU on IDLE, Modem in PSM, RTC on	2.7µA
MCU on IDLE, Modem OFF, RTC on	2.2µA
MCU on IDLE, Modem OFF, RTC off	1.8µA
MCU off, Modem off, no RAM retention, wake on GPIO and reset	1.4µA

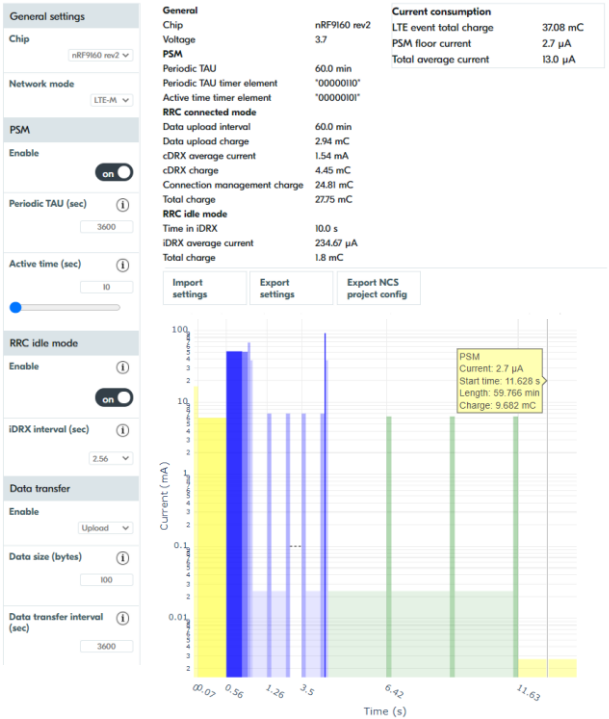
Estimate Power Consumption

Using the Online Power Profiler (OPP)

First Online Power Profiler for cellular IoT

Estimate and optimize your nRF9160 power consumption

- Configure your settings
  - Network setup, Sleep intervals, Data payloads
- Visualized Power Profile
  - Peak current and timing
  - Average
- Extensive User Guide available
- Export nRF Connect SDK project settings to be used with UDP sample
  - Unified solution with the PPK2 to evaluate the estimations vs. real current measurements



Measure Power Consumption

Using the Power Profiler Kit II (PPK2)

Power Profiler Kit II (PPK2)

- Nordic Dev Tool for current measurement and analysis
  - 200nA to 1A current range with resolution varying between 100nA and 1mA
  - 10x faster sampling than first generation PPK
- Measure and analyze any embedded HW, including all Nordic DKs
- Supported by the new Power Profiler app in nRF Connect for Desktop
- Standalone product

Why do developers need this?

- Useful tool to track power consumption
- Ampere meter mode and Source mode
- Detailed data to estimate power consumption and battery life
- Spot and debug unwanted current drain during entire engineering cycle
- Simple and cost-efficient ($89 retail price)

Demonstration:

Estimate Power Using OPP

Demonstration:

Measuring using PPK2

How to optimize for low power

How to Optimize for Low Power

- Get to know your network
  - Estimate power consumption
  - Measure power consumption
- Know that different protocols and cellular technology are more suitable than others based on your application
- *Sleep as much as possible and disable peripherals when not needed, turn OFF logging etc*.
  - Extensive "Power Optimization Guide" on our website
- Edge computing: “Send information not data”
  - Data: Accelerometer data, continuous 3x16-bit values every 100ms
  - Information: The thing fell over sideways hard and is now laying flat

Q&A

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