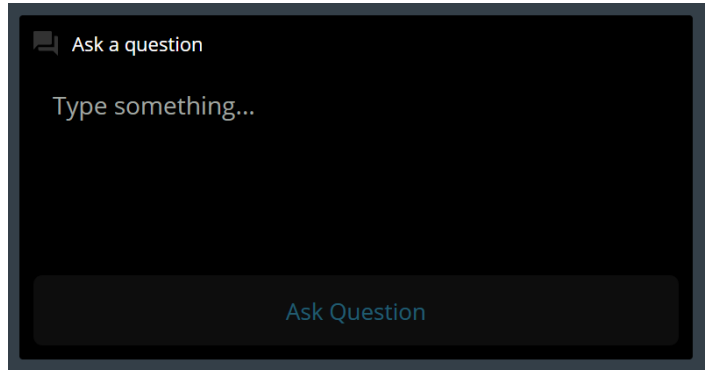
nRF9160 - Putting the "smarts" into Smart meters

Nordic Tech Webinar

Kristian Sæther / Product Manager - Cellular IoT/ January 2021

Practicalities

- Duration: ~45 mins + 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

- Smart meters & Cellular IoT connectivity
- Introduction to nRF9160
- How nRF9160 solves smart metering challenges?
  - Connectivity
  - Flexibility, Integration & edge computing
  - Power Consumption
  - Support

Why do Meters have to be Smart ?

Utility infrastructures are complex to manage and maintain – and the complexity grows

Disruptive technologies are forcing utility infrastructures to evolve* (renewable energies, hydrogen etc)

Governments and people asking for efficient networks and transparency

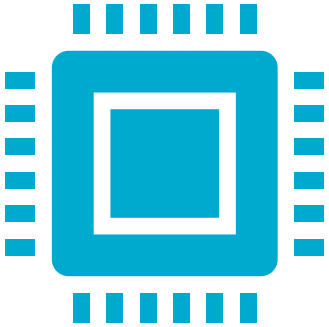
"Smart meters" are meters that enable the collection and processing of metering information in order to:

- Monitor and control the utility infrastructure
- Drive efficiencies in the transmission and distribution networks
- Improve operations
- Make data available (directly / indirectly) to end users to help making smart choices

*Read: Nordic Wireless Q (issue 4 2020) about Hydrogen & Gas meters)

How to get a meter Smart ?

Edge computing



Wireless Connectivity

Cloud/Head-end system

Edge + Connectivity + Cloud = Enabling Smart decisions

It requires seamless exchange of more and more information

Critical: how to design and optimize such flow?

Utilities focusing on their core business

Edge computing Wireless Connectivity Cloud/Head-end system

Head-end system sets requirements on the Wireless Connectivity and vice versa

Important to understand capabilities of each connectivity technologies & protocols

Many utilities opting for different solutions

→Demand for standard-based, interoperable, flexible, global metering solutions

Standard interface

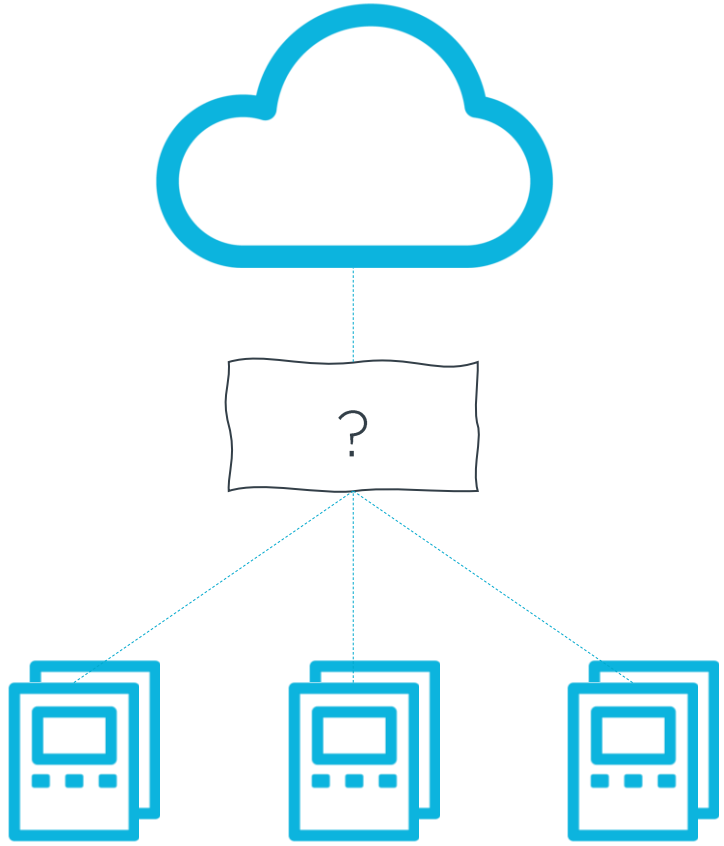
"Outcome based approach"

Utilities want to focus on head-end systems (Data and Device Mgmt)

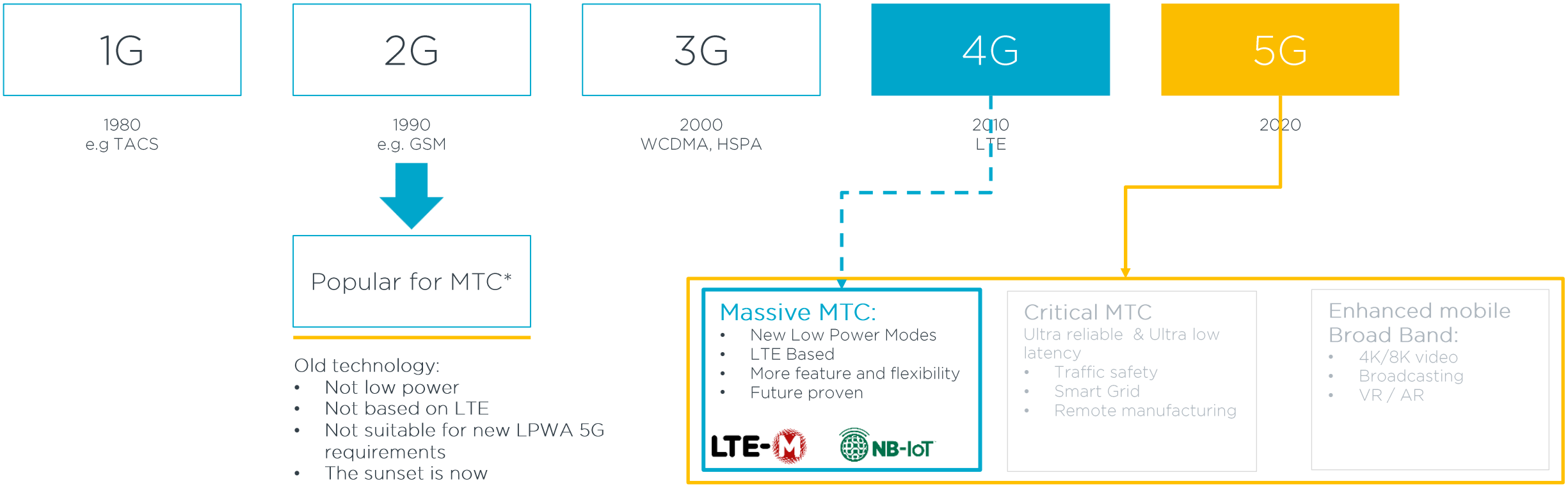
Meter to cloud wireless connectivity

Requirements from Utilities:

- Built on Standards (at multiple levels)
- Low Total Cost of Ownership
  - cost on infrastructure
  - Simple I&C / operations (plug & play)
  - Robust (e.g., FOTA) to limit on-site maintenance
- Secure
- Future proof (15-20years lifespan)
- Scalable (data rate / number of devices)
- Multivendor approach

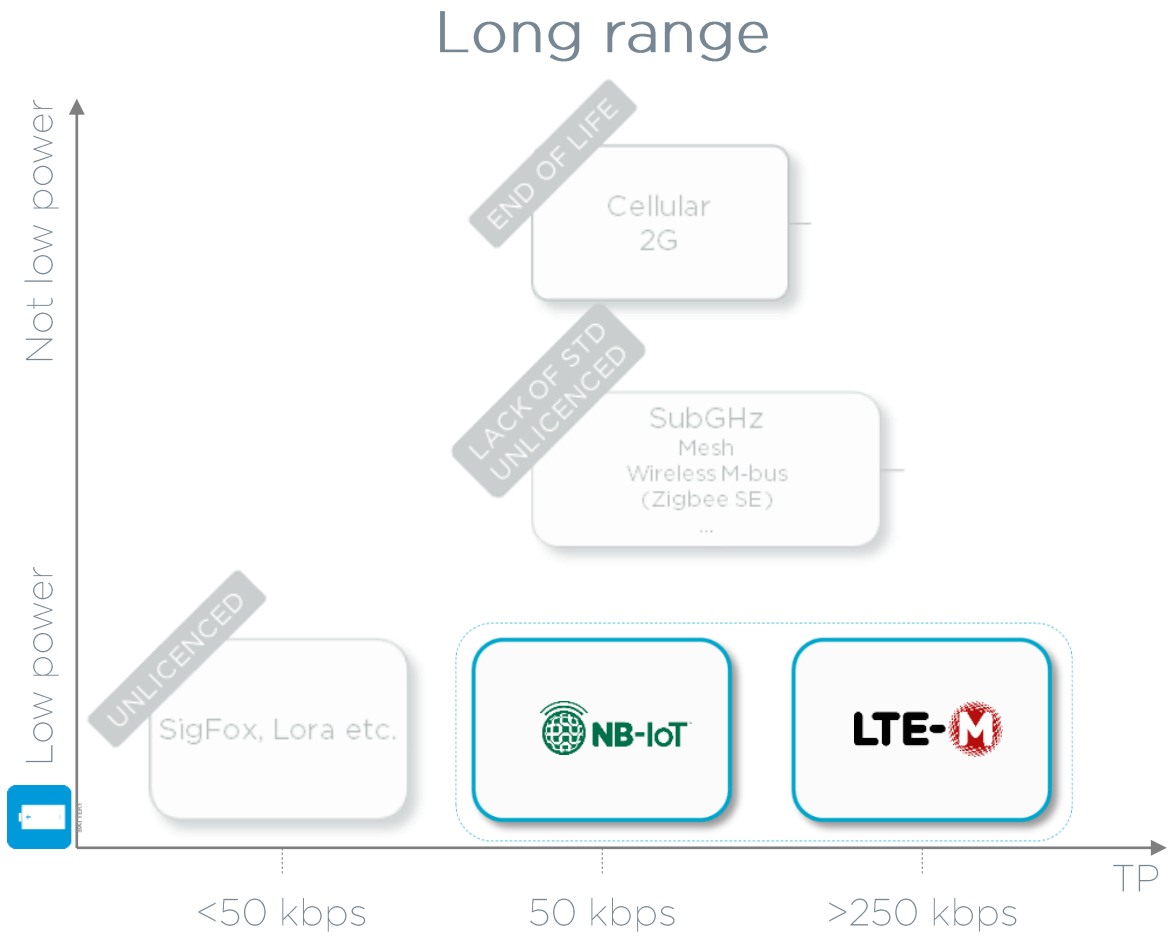


Standardizing the connectivity: Cellular IoT



*MTC = Machine-Type Communications

Wireless technology landscape



Cellular IoT (NB-IoT & LTE-M) is the ideal technology for utilities to connecting smart meters

- ✓ Built on solid standards (3GPP)
- ✓ Enables multi vendor approach
- ✓ Scalable & future proof
- ✓ Low TCO - no infrastructure costs
- ✓ Simple: plug & play
- ✓ Advanced connectivity (low power, coverage, throughput, FOTA, flexible protocols, etc.)
- ✓ Different protocols support different uses cases

Cat-M1, Cat-NB1, Cat-NB2

	Cat. M1	Cat NB1	Cat NB2 (Rel 14)
On air BW Throughput Layer 1	▪ 1.4 MHz BW ▪ >300 kbps	▪ 200 kHz BW ▪ ~60 kbps	▪ 200 kHz BW ▪ ~100-170 kbps
Power consumption	+++	+++	+++
Coverage	++	+++	+++
FW Upgrades (FOTA)	+++	+	++
Latency	+++	--	-
Mobility (LTE)*	Yes	No	Limited
Roaming	Available	Limited	Limited

Electricity

Advanced Gas/water

Gas/water

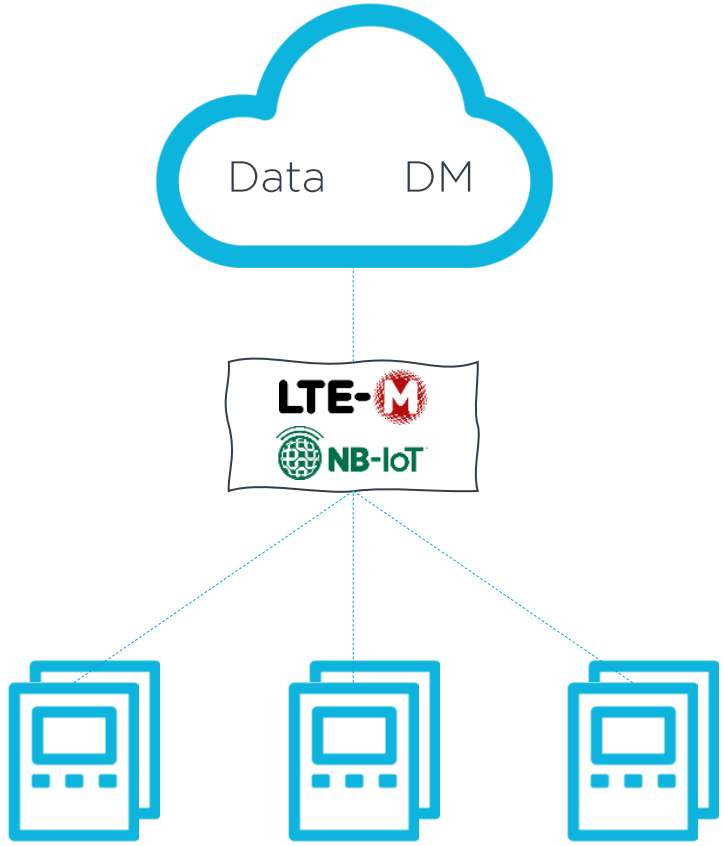
Gas/water

*Remember: stationary devices (e.g. meters) can benefit from Mobility: Radio condition are never stationary!

Meter to cloud connectivity

How to:

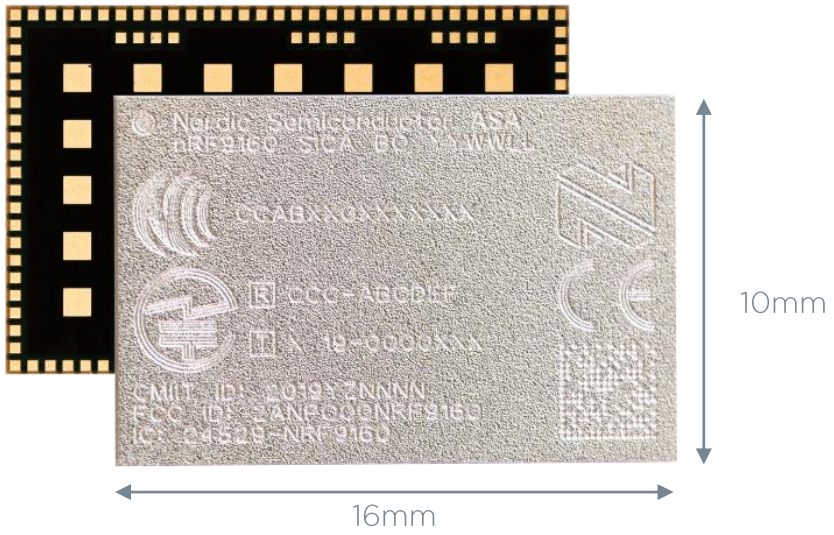
- choose the connectivity (LTE-M vs NB-IoT)
- choose protocols for data (TCP, UDP, MQTT; CoAP, etc)?
- choose the protocol for device management (e.g. LWM2M) to handle many devices?
- add edge-processing and optimize data upload?
- secure the connectivity?
- achieve Low Power?
- achieve Low Latency?
- have built-in flexibility and build a global solution?

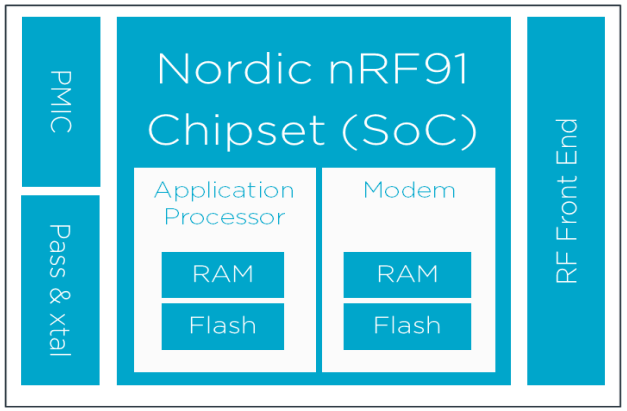


DM= Device Management

nRF9160
simple path to smart meters

This is nRF9160





Based on **Nordic Dual Core chipset**:

- **LTE-M/NB-IoT** modem with **GPS**
- **ARM Cortex M33 MCU** for the application

Certified System in Package (SiP)

Multiband support for global coverage

Small form factor (includes PMIC, RF FEM, passives and crystals)

Ultra Low Power

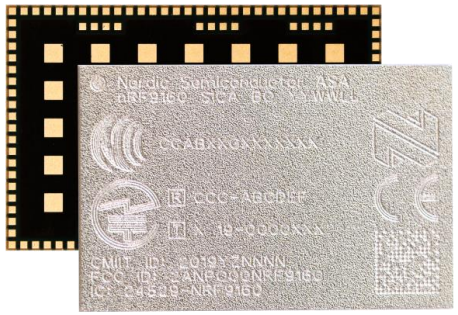
Best in class FEM and Packaging

Optimized Front End

23dBm Max Tx Power
(ideal also for Water / Gas meters; i.e. better coverage)

Very Stable Tx:
Temperature range -40 to 85 °C (3GPP)
(ideal also for electricity meters where temperature can be critical)

Advanced Packaging



Shield technology (“MicroShield™ by Qorvo”) proven in high-volume manufacturing for ~10-years

(Ideal also for water / gas application, where potting is needed)

Certified world-wide band support

Global - 3GPP

GCF™ Global Certification Forum

PTCRB

Completed

Regulatory standards

CE – FCC - ISED - ACMA RCM – NCC – IMDA – MIC – MSIP – IFT - SRRC

Completed

Carrier

AIS, AT&T, Bell, China Telecom, Deutsche Telekom, KDDI, LG U+, SoftBank, Telstra, Verizon, Vodafone

Completed

(+More Coming)

How nRF9160 is solving meter to cloud connectivity

Solving smart meter challanges

Flexibility, Integration & Edge computing

Power Consumption

Support and time to market

Flexibility, Integration & edge computing

The benefits of System on Chip approach

Case study: advanced cloud connectivity

Meter A for utility in USA

- LTE-M
- Data on demand: DLMS over MQTT
- Low Latency response for controlling meter's actuator (e.g. switch off valve)
- HTTPS for Application FOTA
- LWM2M for Carrier Device Management
- Ultra low power

Meter B for utility in Europe

- NB-IoT
- Push Data: UDP Client
- Generic LWM2M for Utility DM
- Ultra low power

Trends:

- More complex protocols (MQTT, CoAP, LWM2M)
- Multiple socket connections to different clouds (data & DM)
- Avanced security (TLS, DTLS)
- More complex application protocols → demand for extra pre-proceesing power to optimize the information to be sent

Important observations*

Cellular standards

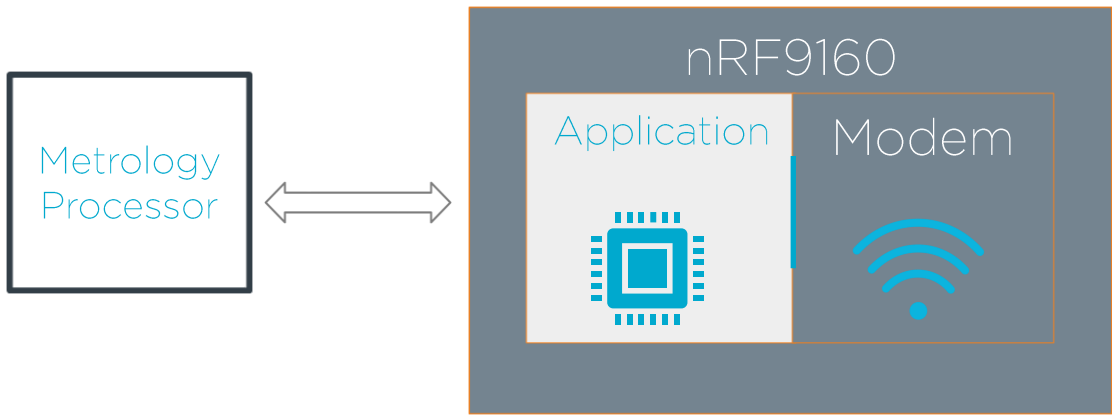
- LTE-M
  - High speed, high capacity
  - Power consumption less correlated with payload size
- NB-IoT
  - Slow, low capacity → NOT suggested for meters with frequent uploads (e.g. electricity meters)
  - Energy consumption linear with payload size
  - Carrier limitations

Application protocols

- MQTT (TCP)
  - Most ideal for larger data packets
  - Popular and well supported protocol
- CoAP
  - Less overhead compared to MQTT
  - Enables reliable UDP → suggested for NB-IoT
  - Not that popular

* Watch Nordic Webinar "Cloud connectivity and protocols for IoT"

Adding nRF9160 to the meters



Edge computing
+
Wireless Connectivity

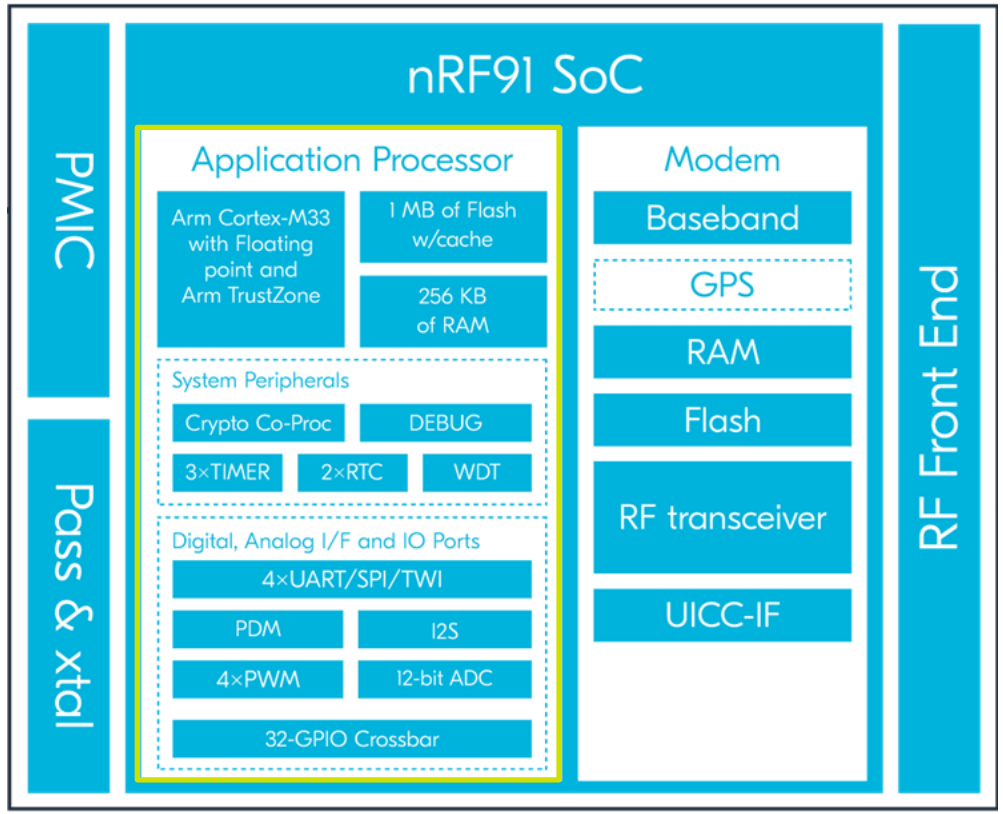
nRF9160 adds both:

- LTE-M /NB-IoT connectivity
- Fully open processing unit with simple development environment

SoC approach:

- Customer application running on the processor
- It adds edge computing capabilities and extra flexibility in protocols stack
- It makes solution more flexible and predictable (e.g. better for power consumption, more flexible sockets)

Dedicated application processor = flexibility



- 64 MHz ARM® Cortex®-M33 CPU
- ARM® Trustzone® for trusted execution
- ARM® Cryptocell 310 for application layer security
- 1 MB Flash & 256 KB RAM
- 4 x SPIM/SPIS/UART/TWIM/TWIS
- PDM, I2S, PWM, ADC
- 32 GPIOs

nRF9160: Flexible and advanced protocols

Nordic has designed the LTE modem

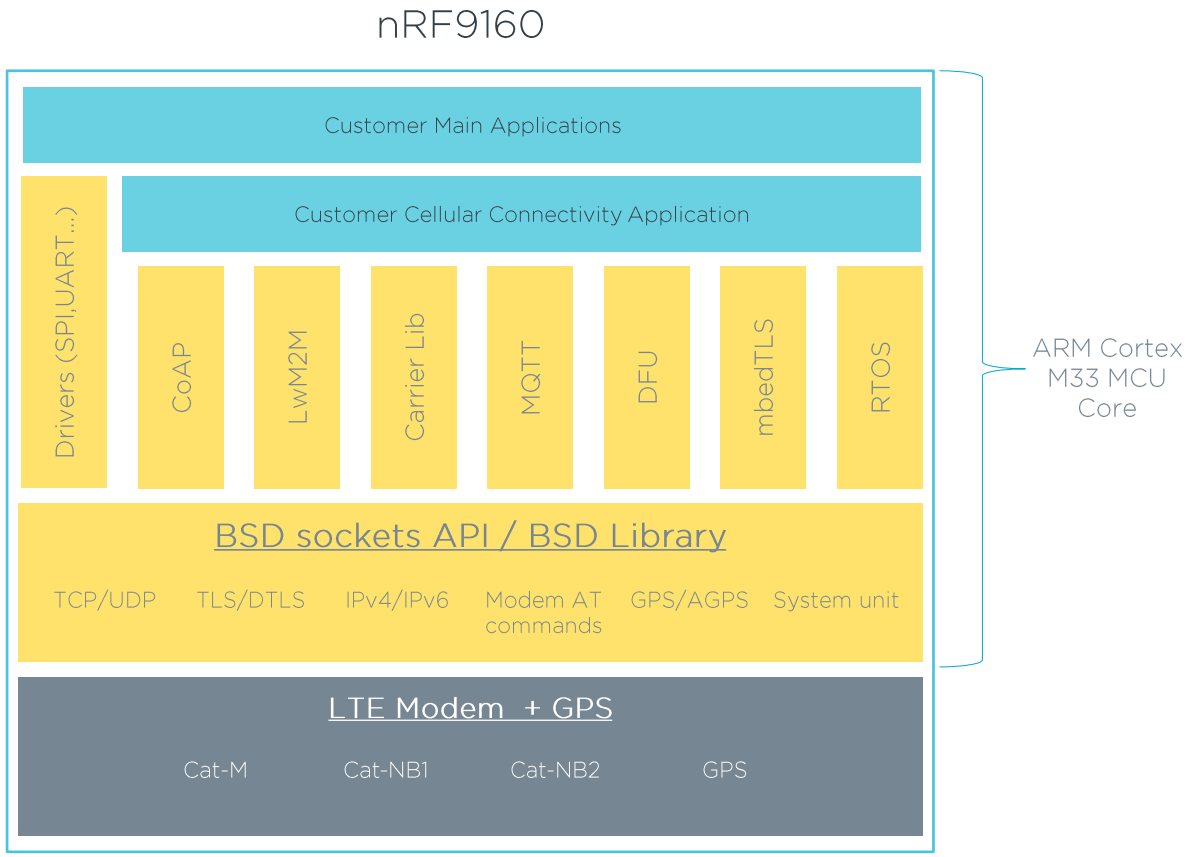
Nordic provides STANDARD BSD Socket API to the modem:

- 8 generic sockets that can be used freely between UDP, TCP, TLS, DTLS, and AT commands
- 1 GNSS/AGPS socket + 1 modem DFU socket + 10 PDN sockets
- Support for both TCP/UDP Client and Server

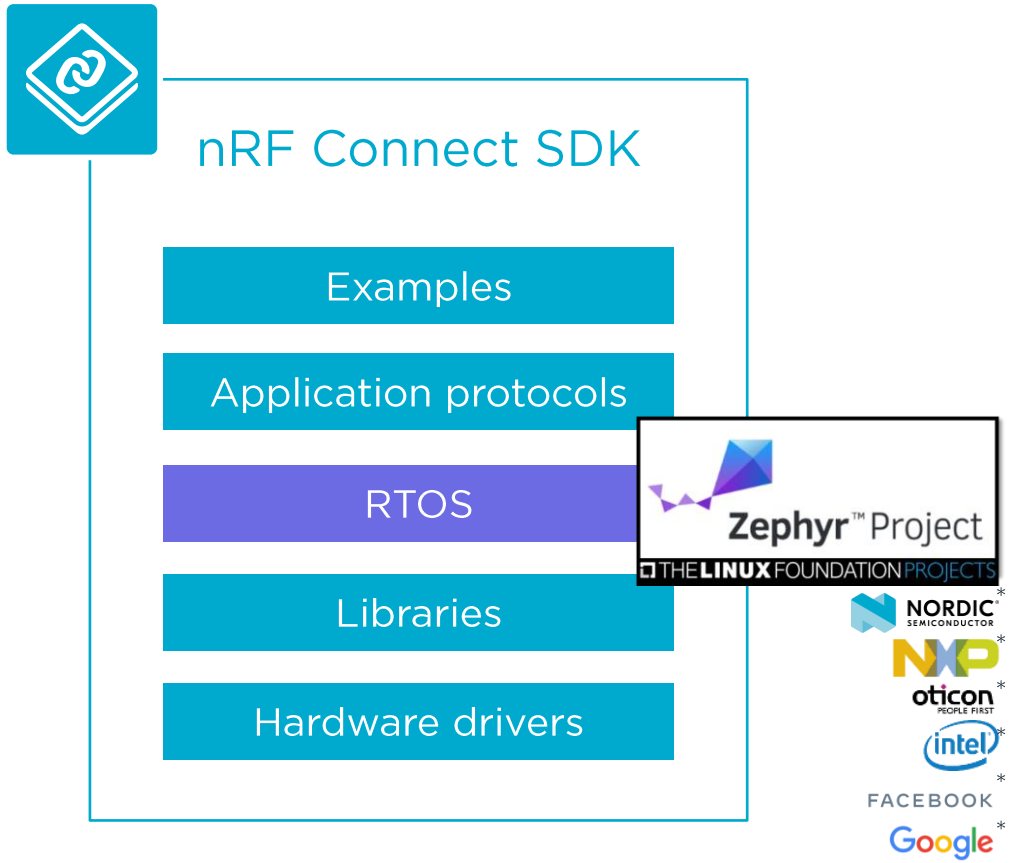
Nordic provides advanced protocols (LWM2M) and security modules (mbedTLS) seamlessly integrated with modem, all included in nRF Connect SDK

Customer can write application easily

- No effort on writing Drivers or to interface to the modem
- Easy for software development. Seamless integration
- More flexible
- Lower Power & Predictable



nRF Connect SDK for application processor

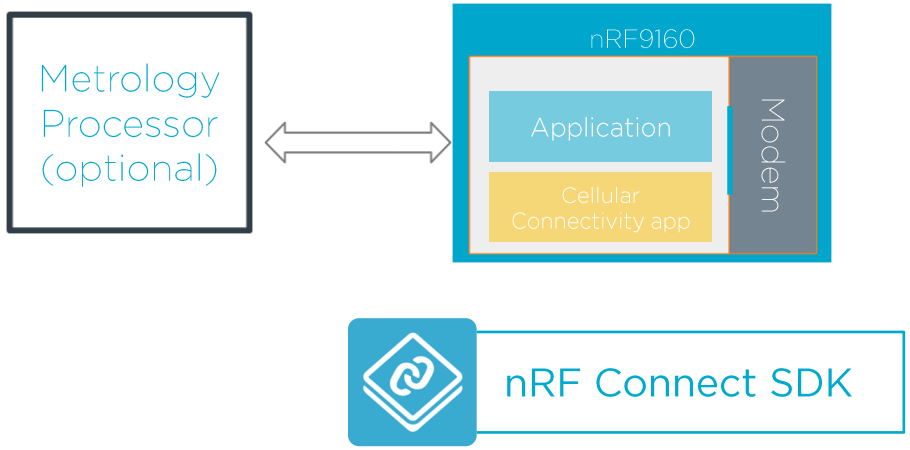


Open MCU with Nordic nRF Connect SDK:

- Modern software development
- Flexible & scalable:
  - Integrated truly opensource RTOS: Zephyr
  - Simple to port code across many vendors boards
- All in one place: Cellular, Bluetooth LE, Bluetooth Mesh, Zigbee, Thread etc
- One code base and toolchain for nRF91, nRF53 and nRF52
  - Optional for nRF52 Series

* Zephyr Platinum members

Summary: nRF9160 SoC (modem+MCU) approach



Support for all major protocols

- e.g. MQTT, CoAP, LWM2M, HTTP(S) etc

Native in nRF Connect SDK→ simple SW development

- Easy to adapt to your needs
- Flexible sockets: connect to multiple Clouds
- LWM2M Client stack is free of charge
- Robust and flexible FOTA
- RTOS for a modular approach
- Cloud examples

Connectivity protocols seamlessly integrated with modem

- Protocol optimized by Nordic to work with the LTE modem: customers can focus on their connectivity application
- Nordic owner of the entire solution (SDK and modem FW)
- Easy to support customers if problems

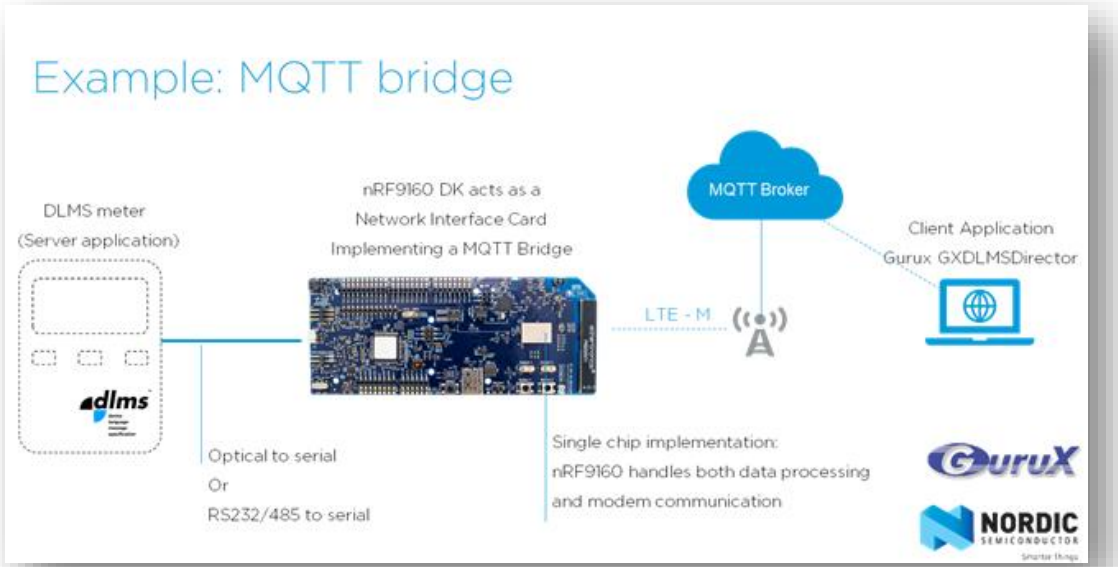
Examples: innovating in smart metering

Cellular IoT, M-Bus and LoRaWAN protocols on single nRF9160 SiP

By Lobaro

https://www.lobaro.com/
https://www.nordicsemi.com/News/2021/01/Lobaro-is-using-nRF9160-SiP-in-its-Wireless-MBus-Gateway

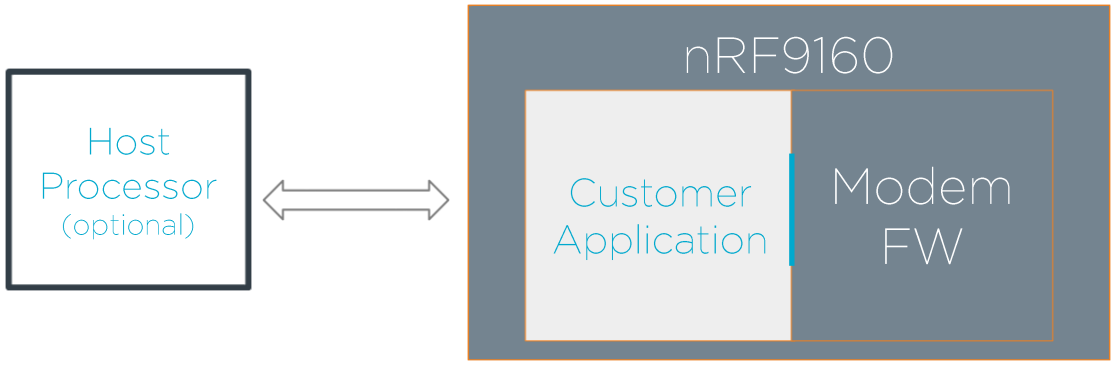
Adding Cellular IoT to DLMS meter by using nRF9160



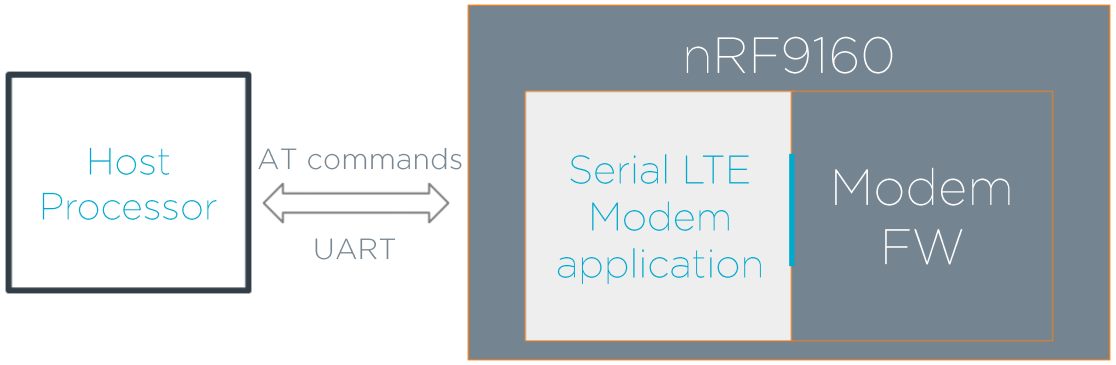
By Gurux & Nordic

https://devzone.nordicsemi.com/f/nordic-q-a/59794/nrf9160-gurux-dlms-server-example/

How to use the application processor in nRF9160



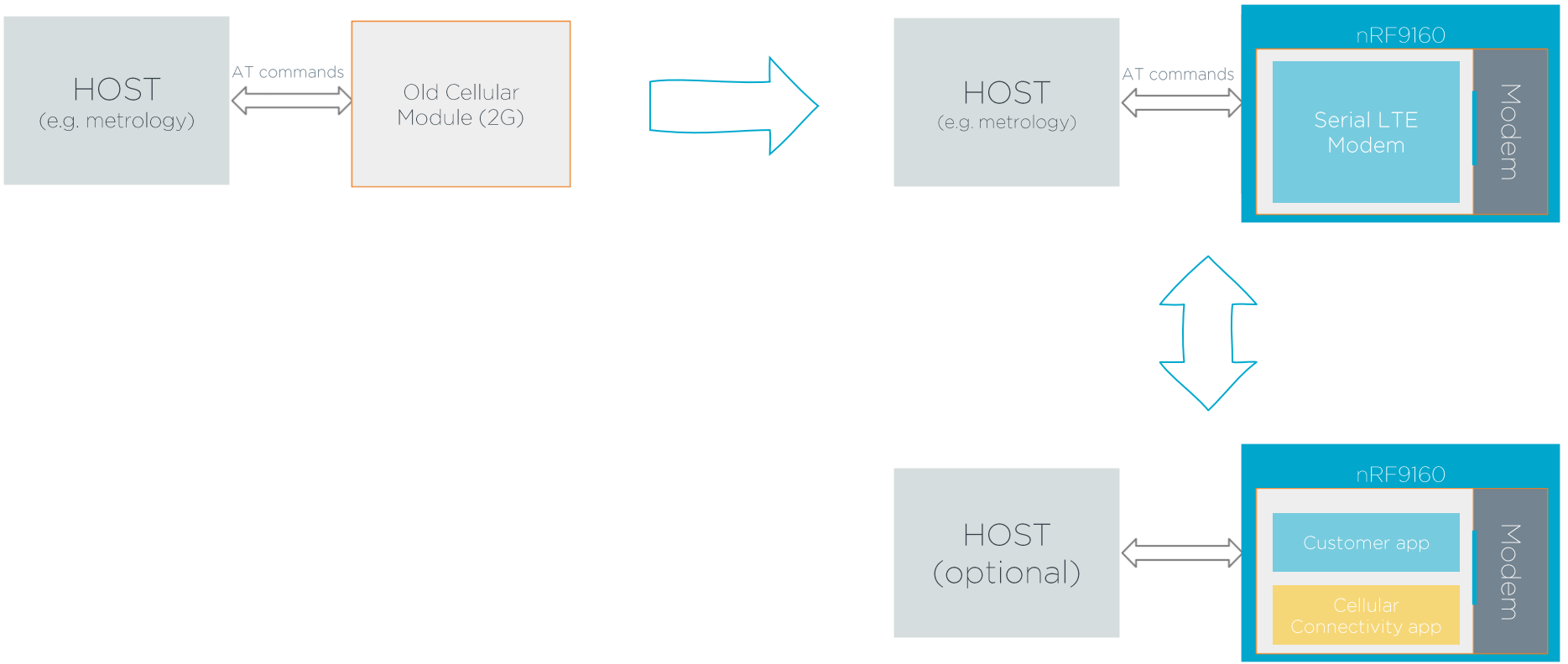
1. SoC approach:
   Your application runs on the nRF9160 application processor



2. Serial LTE Modem*:
   AT Command interface to nRF9160. Open source.

*Watch the Nordic Webinar: "Using the nRF9160 as a Serial LTE Modem"

Serial LTE Modem: simple migration



Power consumption

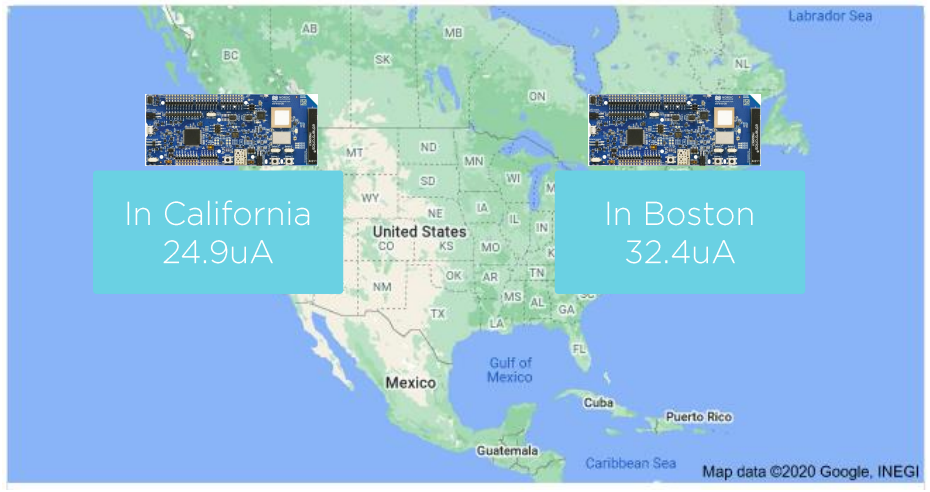
How to have a predictable solution?

You need optimized cellular performances. Always

Question:

Which average 81.92s eDRX current can we expect with nRF9160* in Boston (USA) vs California (USA)?

Same application, same device/product, same network.

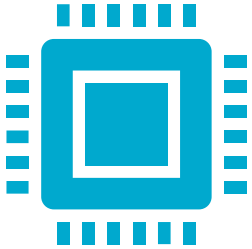


Currents depend also on network settings!

- Cellular is complex: very important to understand how LTE and modem work
- Choose a radio with optimized radio under all network conditions in order to have a solution with predictable power consumption

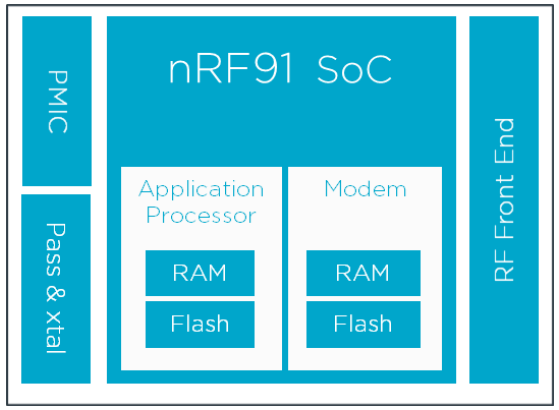
Building Ultra Low Power & predictable products

Optimized HW and SW



Use best in class HW & SW

Smart application



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

Testing

Understand all currents and how LTE works

nRF9160 = Ultra Low Power

Sleep Current Consumption

System Disabled	0.15uA	Device's internal power regulator disabled (entire device down). Reset when powered on.
PSM Floor	2.7uA	LTE modem: RAM fully retained; M33 MCU: in idle with full RAM Retained; RTC on;

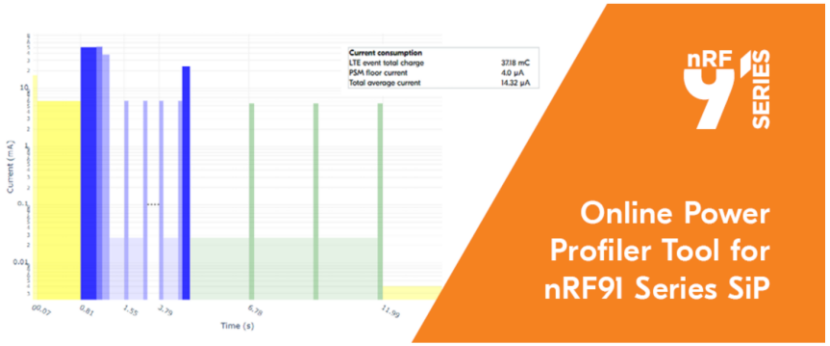
RCC mode – LTE-M

eDRX average current, 81.92 s eDRX, one PO per PTW, PTW = 2.56 s	18uA	This is cycle average current, no repetitions, DRX is set by network – in this case DRX 2.56s No extra calibration currents needed Ultra low eDRX floor < 6uA
Idle eDRX average current, 655 s, one PO per PTW, PTW = 2.56 s	6uA	
Uplink 180 kbit/s, Pout 23 dBm,	115mA	RMC settings as per 3GPP TS 36.521-1 Annex A.2

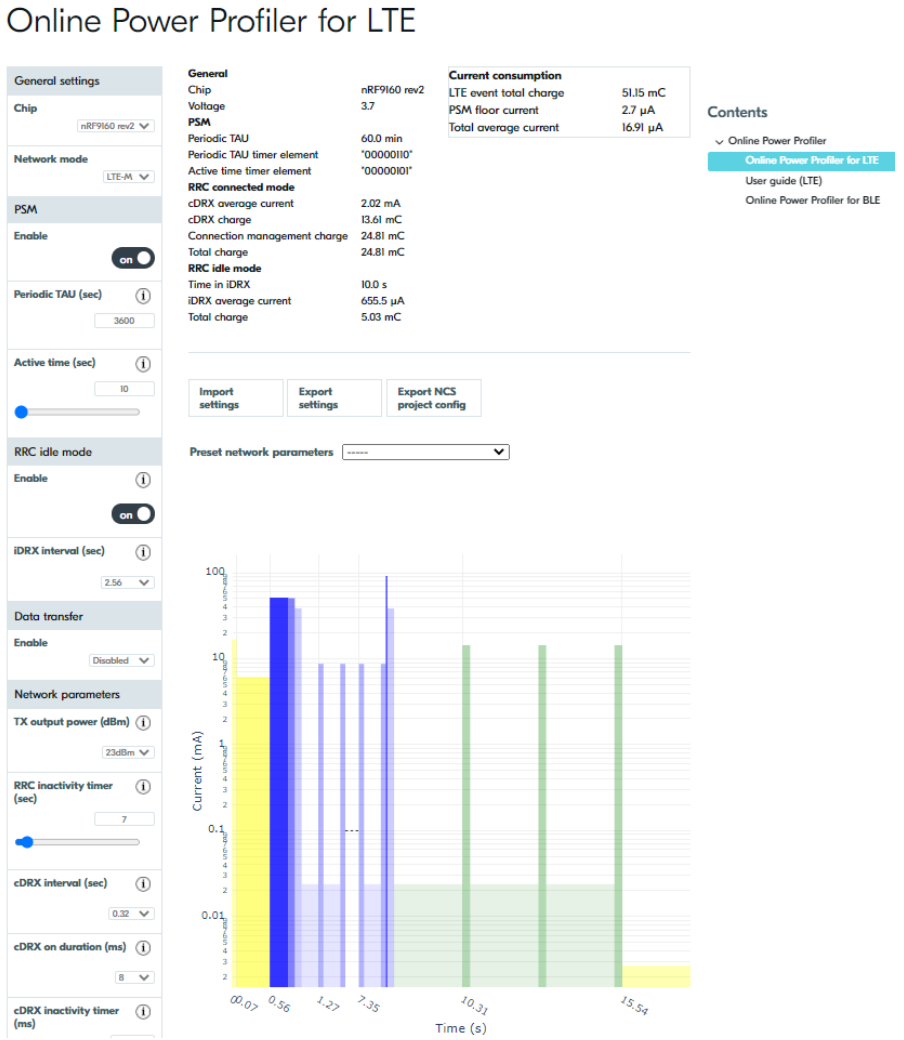
Leverage the new features PSM and eDRX in your meter design.
Forget about 2G!

3.7 V, Typical values, Non including SIM

Online Power Profiler for LTE

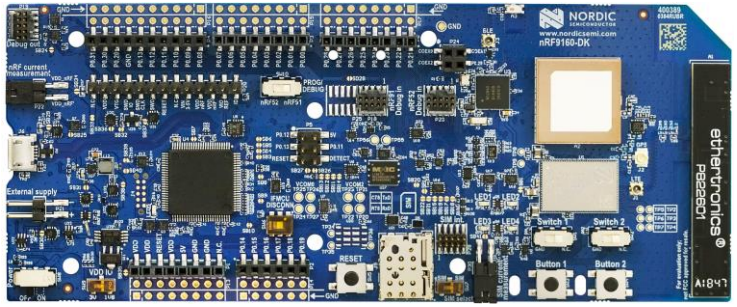


https://devzone.nordicsemi.com/



Measure it yourself!

New DevKit



New nRF9160 DK v1.0 optimized for power measurements

PPK II*

New Power Profiler Kit (2nd Gen)

Advanced Low Cost

Power analyzer

New Tools and SW

Online power profiler

New application examples:

UDP

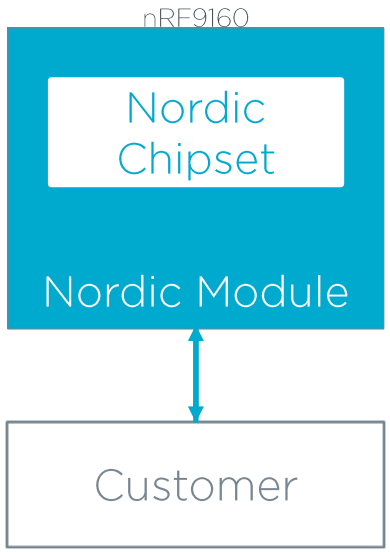
Serial LTE Modem

* Watch Nordic Webinar: "Become An Expert On Power Profiling Your Application"

Support

Direct technical support – down to chipset!

Full Ownership of the solution



150+ LTE engineers, in-house
In house chipset design

Online Technical Support Center and Local FAEs

https://devzone.nordicsemi.com/

24h response time
Private or public tickets
Experts from R&D
Forum with 70K users

Open documentation:
https://infocenter.nordicsemi.com/index.jsp
https://developer.nordicsemi.com/nRF_Connect_SDK/doc/latest/nrf/index.html

Nordic GitHub

https://github.com/NordicSemiconductor
80+ Repos,
Examples, SDK, more

nRF Connect SDK:
https://github.com/nrfconnect

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Q&A

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