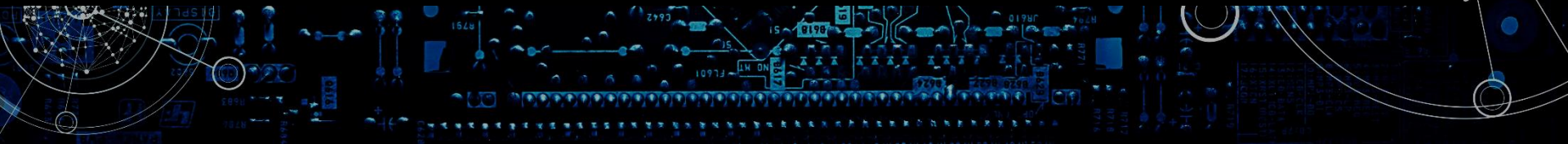


nRF91[®] low power cellular IoT

A 'sneak peek'

January 22, 2018, Oslo, Norway





Welcome!

Svenn-Tore Larsen, CEO



I am proud and excited today

3-years ago...



Seasoned cellular R&D team
Desire to work on something different

Low power expertise and DNA
Broad market engagement model



nRF91 sneak peek

Thomas Embla Bonnerud, Director of Strategy and IR



Cellular technology has changed our life



Always connected

Wherever, whenever

Blazing speed

Productivity and entertainment

Reliable and secure

Hassle and risk free connectivity

Cellular unique value proposal for IoT



Always
connected

- Mobility and roaming
- Independence from local area networks



Reliability
and scalability

- Managed frequency spectrum and SLA's
- Proven scalability



Secure

- End-to-end IP security
- SIM and eSIMs

Technical barriers of adoption in IoT



Power consumption

Cannot charge battery everyday

Little need for very high data throughput

Size

Space constrained devices

Extended coverage and density

Rural and deep indoor deployments

Massive deployments

A man in a white shirt is shown from the side, resting his head on the keyboard of a laptop. The scene is dimly lit, with a dark background. Overlaid on the image are several faint, white line-art graphics: gears of various sizes and a complex, tangled scribble of lines that resembles a brain or a network of connections. The text "Cellular is not easy..." is centered over the man's head and the laptop keyboard.

Cellular is not easy...

... it is actually pretty difficult

Getting hold
of everything

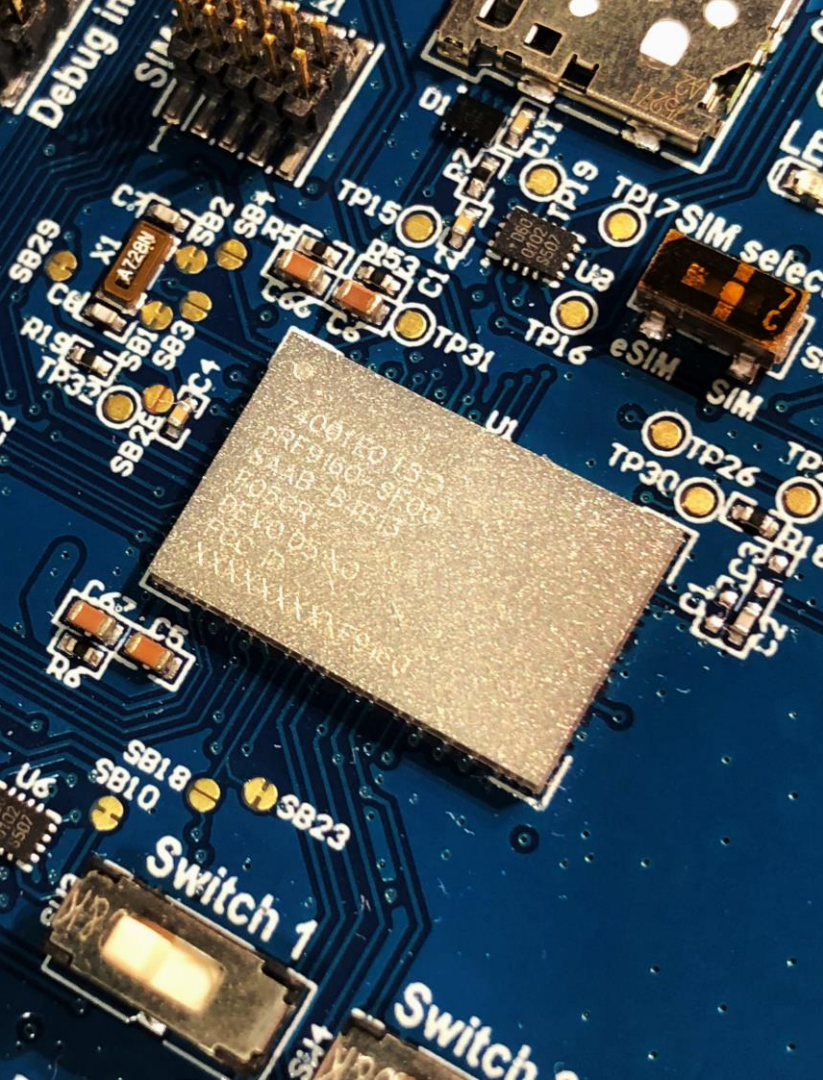
Multiple bits and pieces
Hardware and software

Getting it
to work

Stitching everything together
Getting support

Deploying
the product

Certifications
Regional differences



This is nRF91

Cellular made easy

Lower barriers of adoption

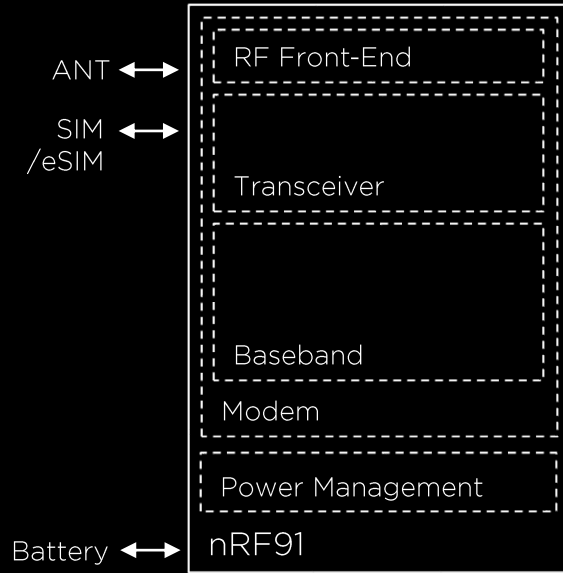
Drive innovation and enable new markets

Cellular for everything else

Designed and optimized for IoT applications

Lower power, smaller size and improved coverage

Low power cellular connectivity made easy

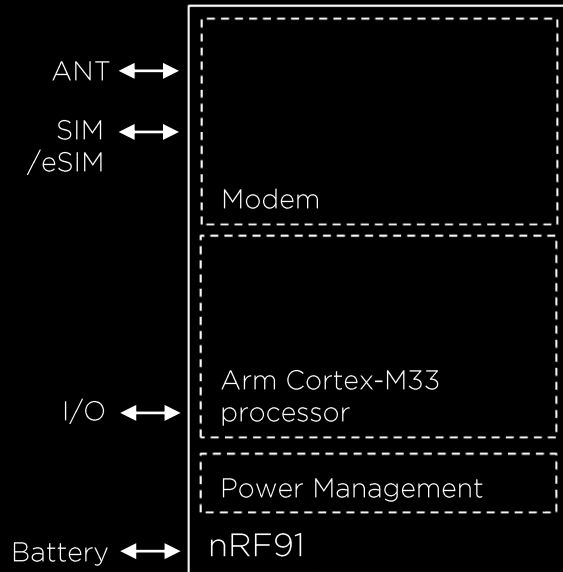


Complete modem in a package
Multimode LTE-M / NB-IoT

All the benefits of a traditional module
Ease of integration and use
Teleregulatory, standard and carrier certifications

Global operation with one variant
Multiband support for world wide coverage

Complete cellular IoT system made easy



Integrated processor the for application
Arm® Cortex®-M33 core, embedded flash and RAM
Rich set of system peripheral and interfaces

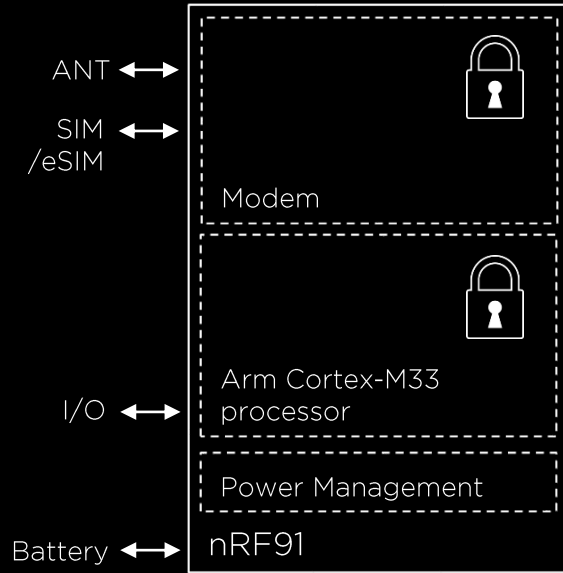
Complete cellular IoT system in package
Integrated connectivity and application

Lower power, smaller size and lower eBOM
Compared to using external processors



Security is a big deal for IoT

System level solution for IoT security



Secure connectivity

Cellular network, end-to-end internet protocol security
Modem is a separate secure island

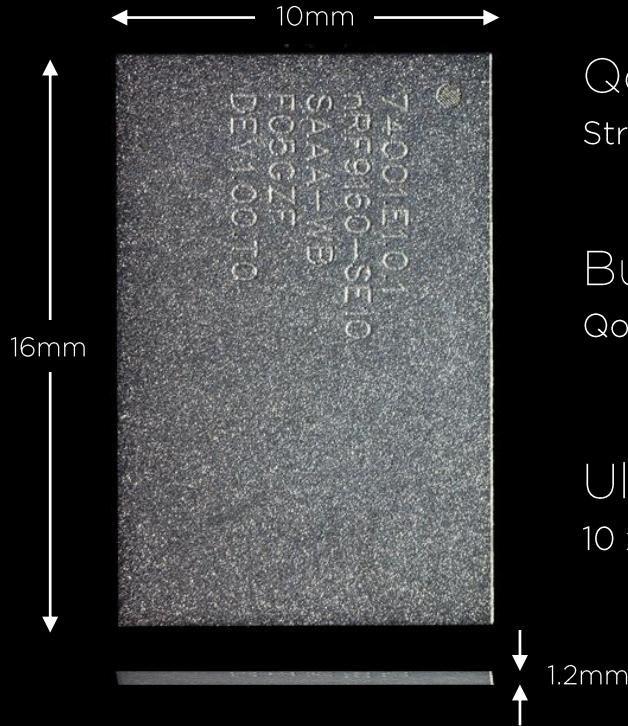
Secure application

Arm® TrustZone® for ARMv8 and CryptoCell® technology
Root of trust and trusted execution environment

Secure over-the-air updates

Modem and application firmware updates
Embedded flash

Advanced System-in-Package assembly



Qorvo × Nordic Semiconductor

Strategic partnership for SiP development and manufacturing

Built-in global RF Front-End and shield

Qorvo custom RF Front-End and MicroShield™ technology

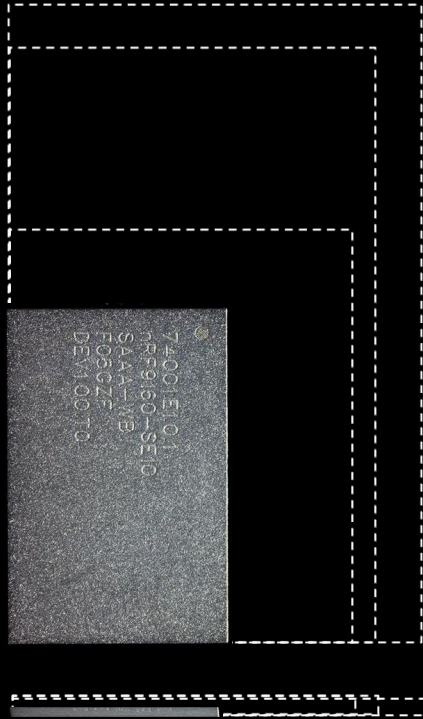
Ultra-compact form factor

10 x 16 x 1.2mm

qorvo®

all around you

New industry benchmark on solution size



Up to 3x
smaller footprint

Up to 2x
thinner

Up 5x
less volume



MANUFACTURING PLANT

GLOBAL FACILITY INSIGHT



CUSTOMER SITE

Monitor production flow in near-real time

Remotely Manage Equipment

Transmits operational information to the partner (e.g. OEM) and to field service engineers

Where are my things?

... and in what condition are my things?

Condition-based maintenance.
Predictive maintenance

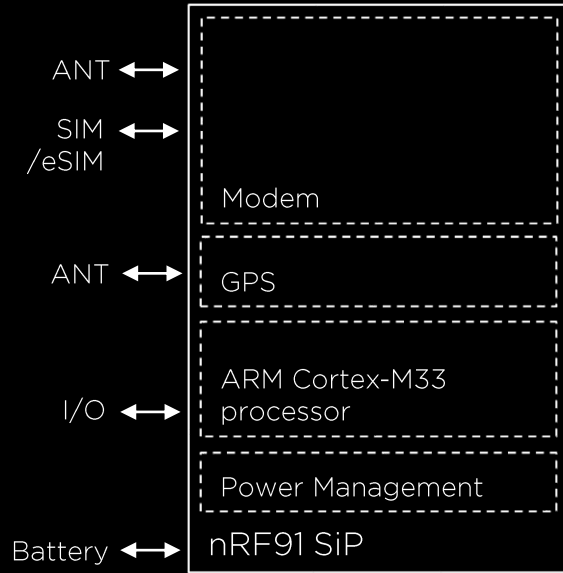
Identify and correct quality issues.
Inventory Management

Provide cross-channel visibility into inventories.

Tracking, predictive maintenance and beyond in IoT

THIRD-PARTY LOGISTICS

Built-in Assisted GPS for positioning



Support for cellular based positioning
Modem support for Enhanced Cell ID and OTDOA

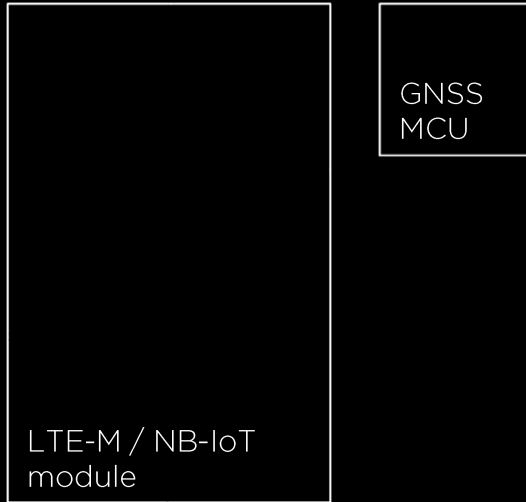
Built-in GPS receiver
Optimized for asset tracking

Assisted GPS for fast-time-to-fix
Combines cellular and GPS position data

New industry benchmark on integration

Cellular tracker solution

Announced at CES 2018
Module + chip solution



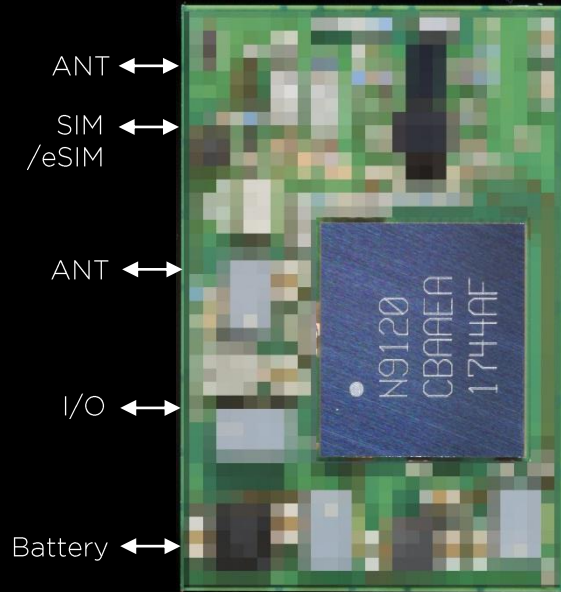
nRF91 solution

Single SiP solution



Up to 4x smaller footprint

Nordic System-on-Chip inside



Custom highly integrated SoC

Multimode LTE-M/NB-IoT modem baseband and transceiver,
Processor for application, embedded Flash and RAM
GPS receiver and power management

Finland × Norway chip design

Unique combination of cellular and ultra-low power expertise

Optimized for power and size

Built from scratch for LTE-M and NB-IoT

Demo

Telia × Nordic Semiconductor

Cellular IoT demo set-up

nRF Connect for Cloud



Cellular network
(LTE-M)



Peder's
nRF91 demo kit



Cellular made easy, cellular for everything else

Complete software solution
Modem firmware for cellular connectivity
SDK for application

Easy-to-use development tools
Development kits
Software tools



Support and community
Nordic tech support and FAEs
Nordic Developer Zone

Out-of-the-box cloud connectivity
Nordic nRF Connect for Cloud

Cellular IoT demo set-up

nRF Connect for Cloud



Cellular network
(LTE-M)



Chris'

nRF91 demo kit

Verizon

Wireless Network



Under the hood

Peder Rand, Product Manager Cellular IoT

nRF91 Cellular Connectivity

Coverage

- 23 dBm output power
- -108 dBm LTE-M sensitivity
- 700 MHz – 2.2 GHz
- Up to 4x LTE range with LTE-M
- Up to 7x LTE range with NB-IoT

Throughput

- Up to 360 kbps with LTE-M
- Up to 60 kbps with NB-IoT

QoS

- Switch between LTE-M and NB-IoT to find service globally
- Mobility supported in LTE-M

Industry obfuscation on power consumption

5 – 10X

battery life

Versus what?

10+ years

battery life

Doing what?

With what battery?

Power Consumption

~ 15 μ A

Connected with 10 minutes
downlink latency (eDRX)
More than 15 years battery life

~ 0.5 mA

Sending tracking information
every 20s (DRX)
More than 6 months battery life

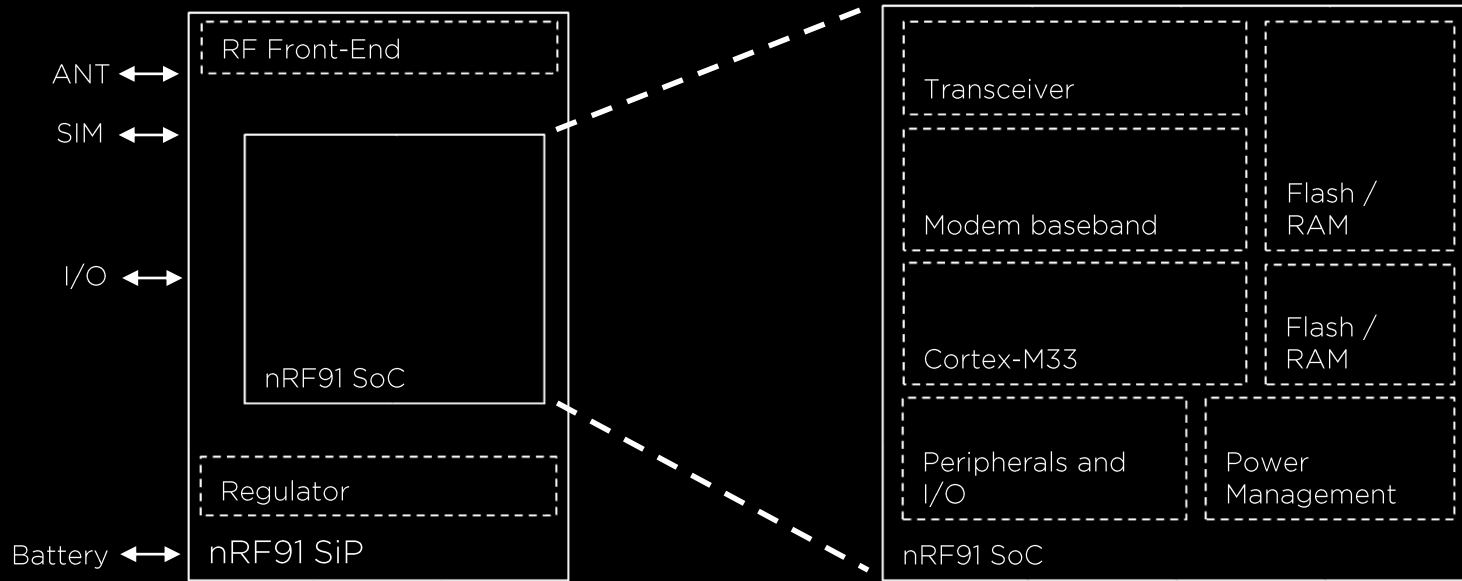
~ 150 mA

Downloading new firmware @
360 kbps (RRC Connected)
A 512 KB image updated in 30 s

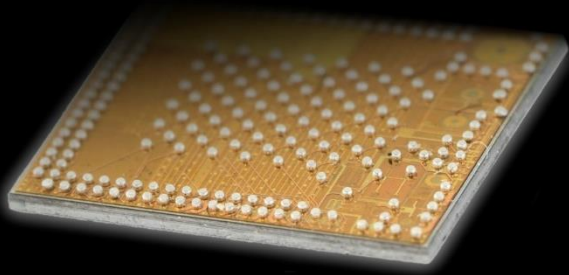
LTE-M, 23 dBm, 3.7 V, 2700 mAh

© NORDIC SEMICONDUCTOR

Highly integrated single chip SoC



The nRF91 SoC



Designed for low power

Uses integrated memories and low-leakage process features extensively

Common power management and clock system for modem and application

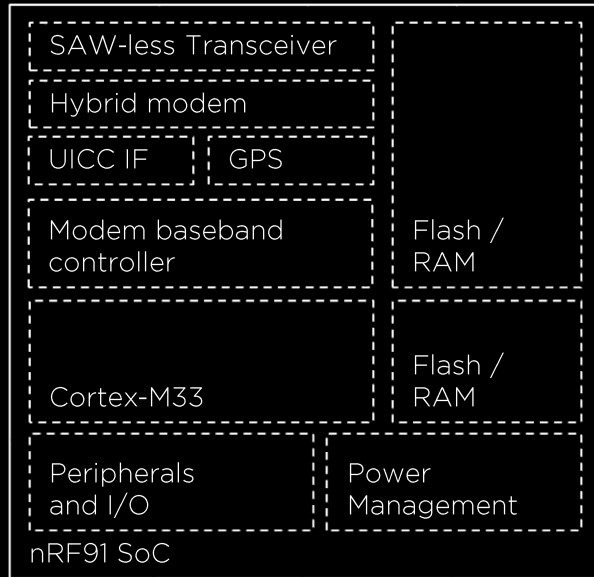
Tight integration

Efficient, on-chip data and control transfer between application and modem

Multiple Secure Islands

Modular approach to security

Modem Architecture



Low power architecture

Hybrid modem and general purpose stack processing for low power

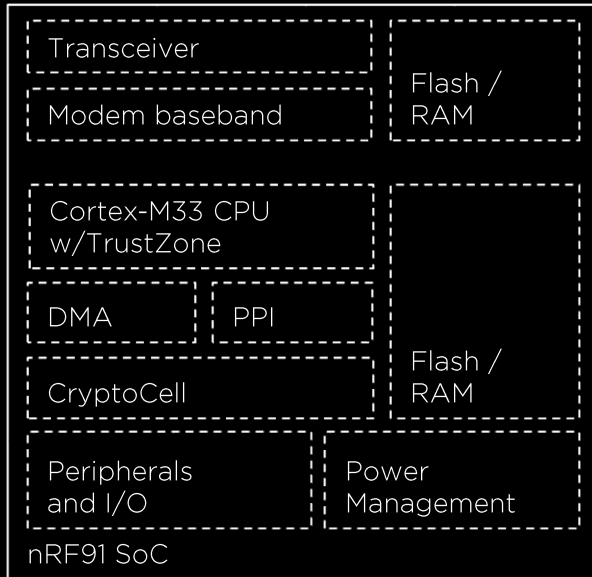
No memory loading

Modem runs from embedded flash/RAM for fast startup times and flexibility

Flexible transceiver

Wide range of bands supported for world-wide operation

Application Processor for Edge Computing



Evolved

Cutting-edge M-class, low power application processor with trusted execution support

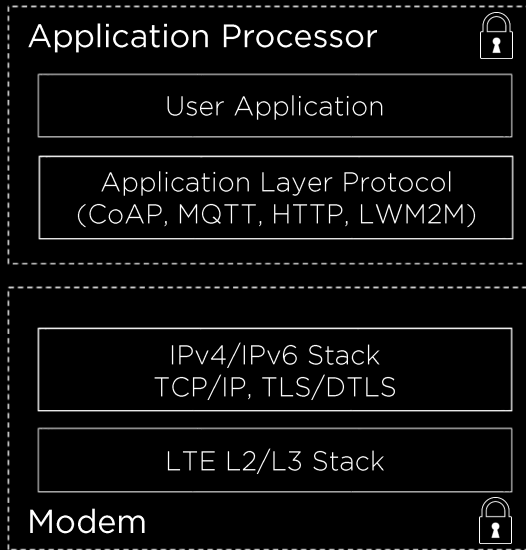
Powerful Peripherals

Draws from the nRF52 pool of low-power peripherals
Interface to any sensor or external system

Edge Computing

Processing and memory resources for low-power edge computing – send information, not data

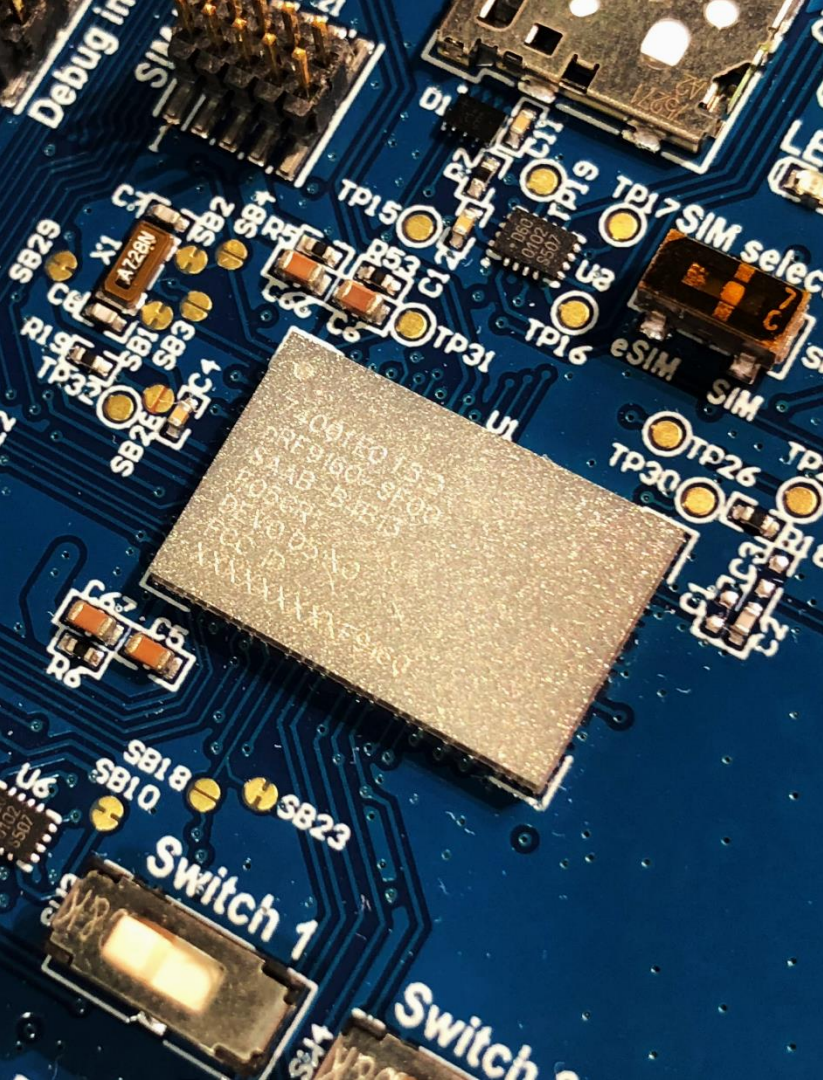
Our Software



Full application development SDK

nRF Connect for Cloud application works
out-of-the-box

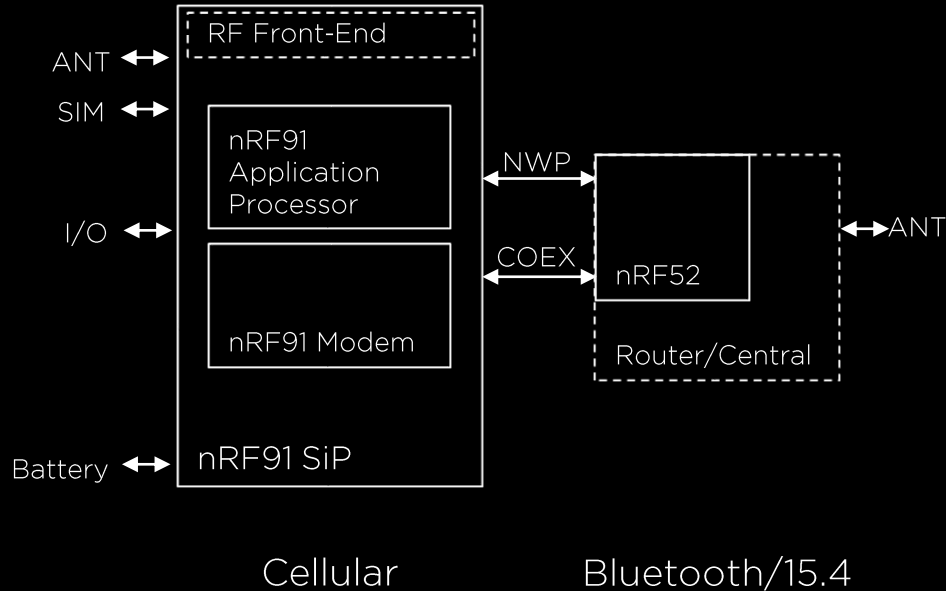
Comprehensive sample applications



Integrating the nRF91 SiP

- 10 mm x 16 mm LGA, 0.5 mm pitch
- Simple 4-layer PCB
- 32 GPIO + coexistence interface + trace/debug
- Single-ended 50 Ω RF
- Integrated crystals and passives
- Single 3.1 V – 5.5 V supply
- Industrial -40°C to +85°C temperature range

Mix and match with Bluetooth



Chipset approach

Automatic coexistence interface

Software drivers and sample application in the SDK

Easy to use, low cost development kit

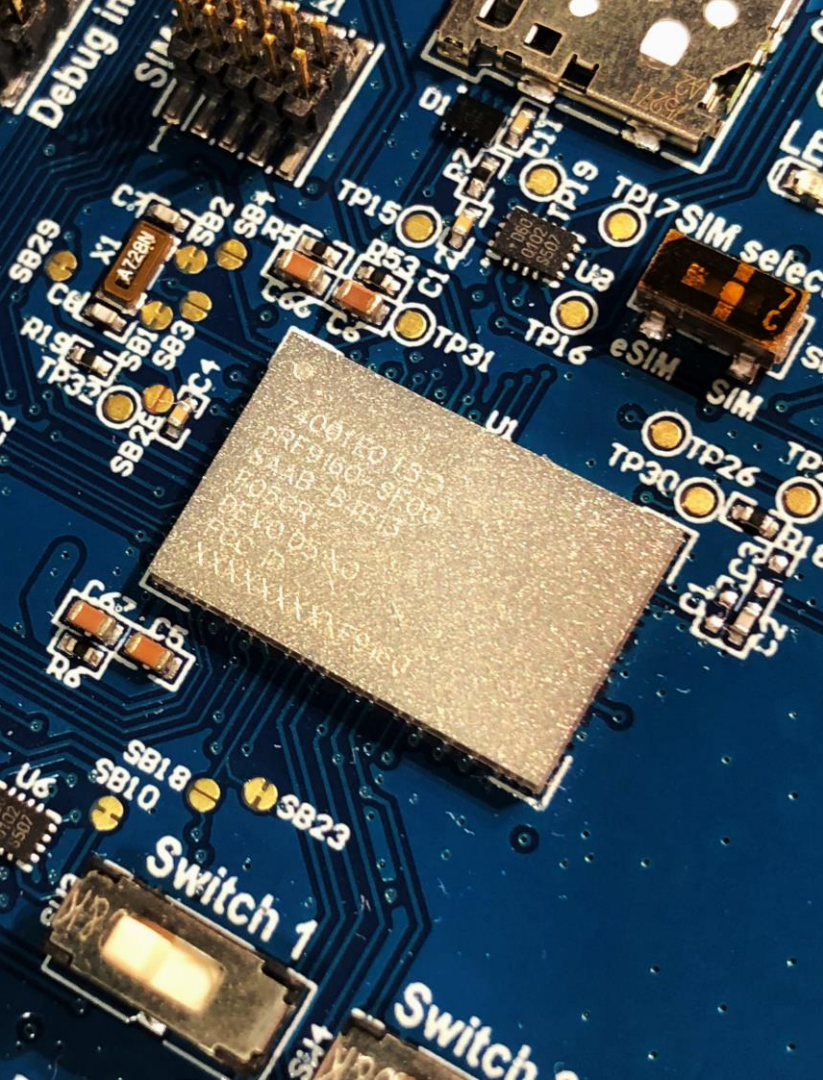


Wide band antenna for world-wide operation

ARM debug and trace on-board

Bluetooth on-board

Supports Arduino Uno Shields



This is nRF91

Cellular made easy

Lower barriers of adoption

Drive innovation and enable new markets

Cellular for everything else

Designed and optimized for IoT applications

Lower power, smaller size and improved coverage

We can't wait to get it into your hands!

Now

Lead customer
sampling program

- Started December 2017
- Expanding through H1 2018
- Engineering samples, kits and software
- Close and dedicated support

Mid-2018

Start of general
sampling

- Phased regional roll-out
- Engineering samples, kits and software
- Available through distribution channels

End 2018

First production
quantities

- Phased regional roll-out
- Regulatory and carrier certifications
- Production ready hardware and software

Thanks!



qorvo[®]
all around you



