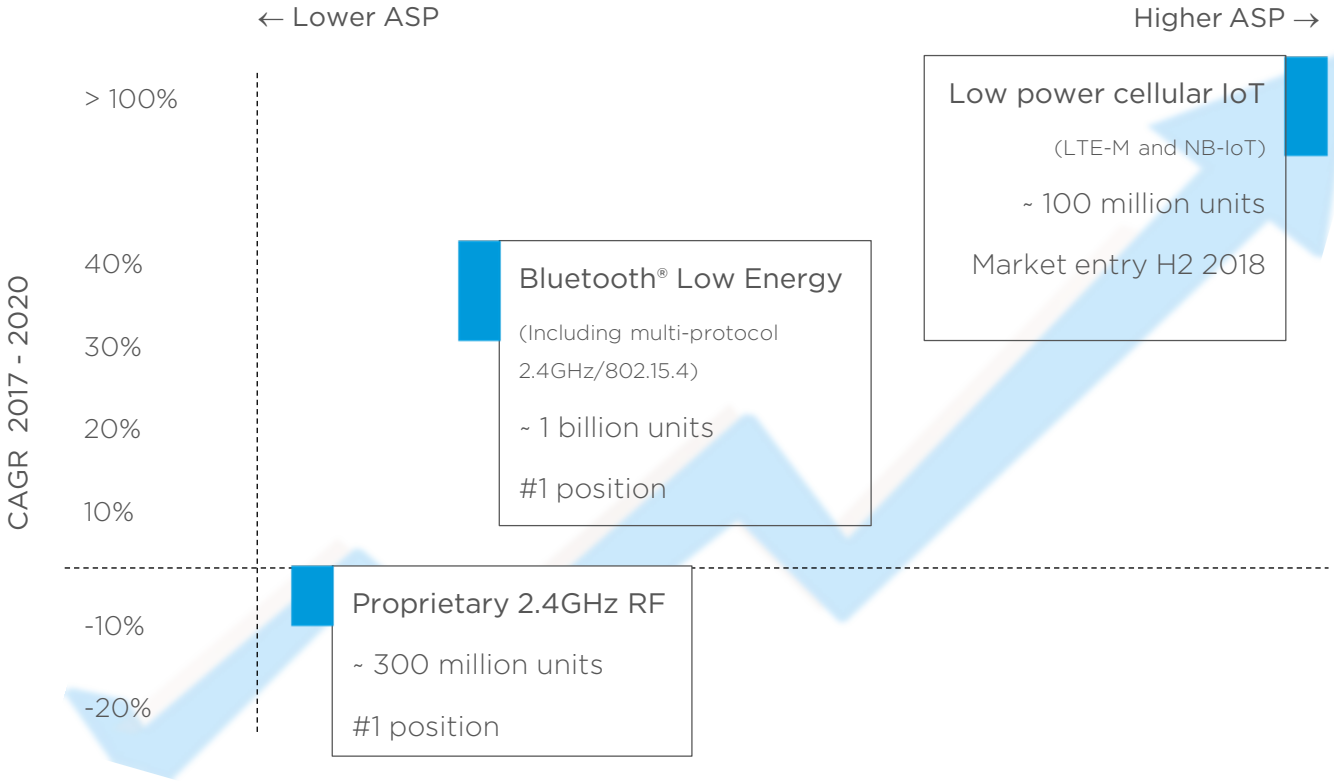
Cellular IoT Analyst Briefing

Oulu, August 23, 2018

Agenda

- Introduction
- Nordic Semiconductor OY and cellular IoT development
- Tour of Facilities
- Cellular made easy – cellular for everything else
- Cellular IoT primer
- Nordic cellular IoT offering
- Demos
- Certifications
- Customer Sampling

Unique position in fast growing IoT markets

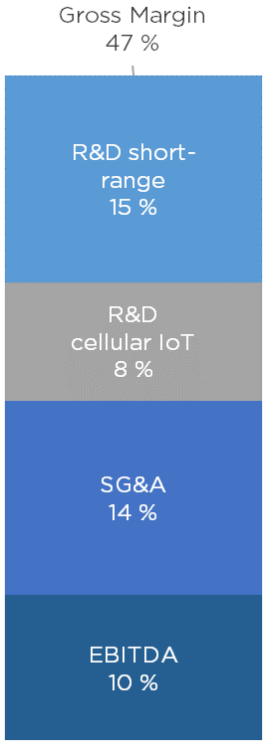


Diversification

- Consumer
- Industrial
- Enterprise
- Automotive
- Healthcare
- Smart City
- Agriculture
- Utilities

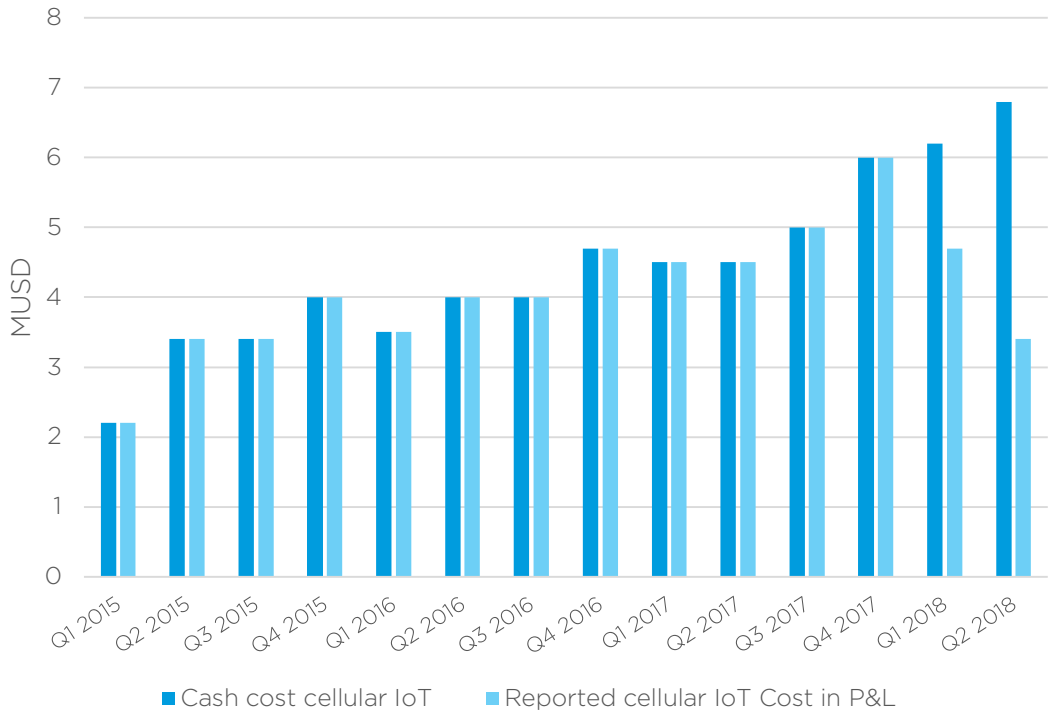
Source: Nordic management and industry reports

Full year 2017 operating model



	2017	2016	
Revenue growth y-o-y	+19% (MUSD 236)	+2% (MUSD 198)	(+17pp) Bluetooth +40% and Proprietary -6%
Gross margin	47.2%	47.0%	(+0.2pp) Gross margin recovery from 46,2% in Q3 2016, closing in on 50% target
R&D short-range	15%	15%	(+0.2pp) Investment for continued growth and expansion in short-range IoT
R&D cellular IoT	8%	8%	(±0.0pp) Investment for accelerated revenue growth and improved profitability on a mid term basis
SG&A	14%	13%	(+1pp) Organizational scaling to manage and fuel growth
EBITDA margin	10%	11%	(-1pp) Continued impact from cellular IoT investment

Cellular IoT Investments



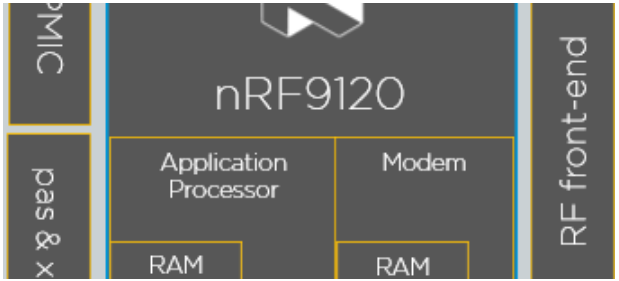
- Invested more than MUSD 62 in cash cost since project start
- From 2018 project is in commercialization phase reducing the net reported opex
- Investments continue to grow, but reiterate target to be profitable based on annual cost in 2020

Proud and excited with our achievement

Time to market

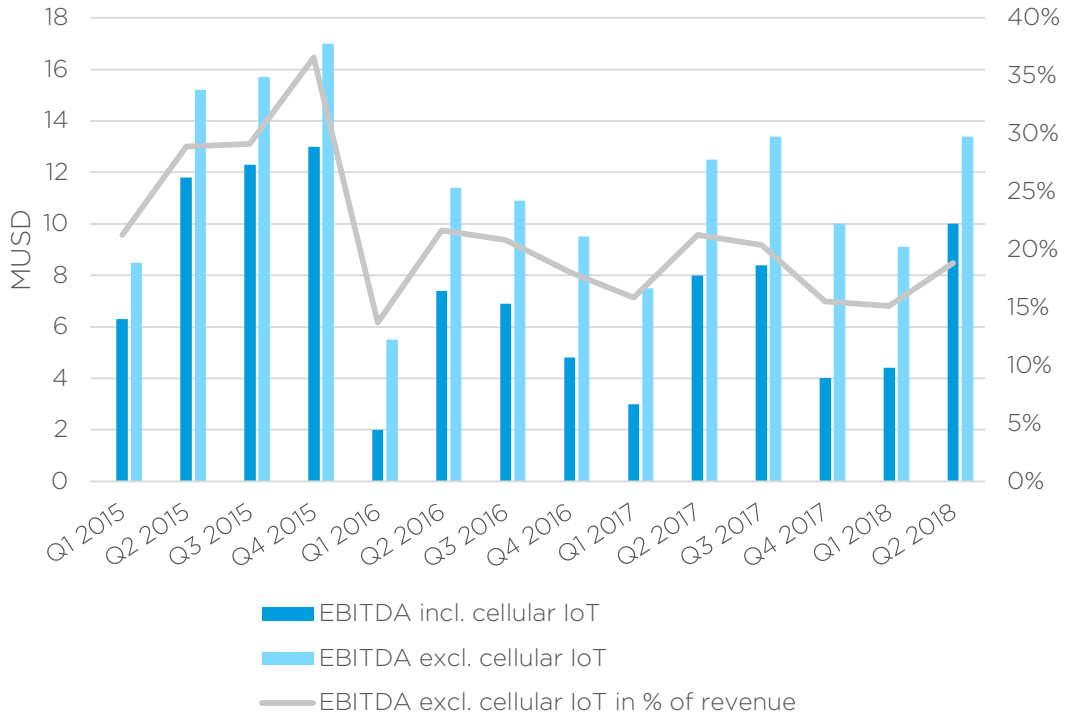
Less than 3 years from start to sampling customers

Solution



Built the most advanced cellular IoT product

Highly successful short-range business



- Short-range EBITDA in the period MUSD 160 – funding entire LTE investment
- In the period, average adjusted EBITDA margin of 21%
- Synergies between short-range and LTE to drive operational leverage

Business aspiration for cellular IoT

Short-term (~2018)

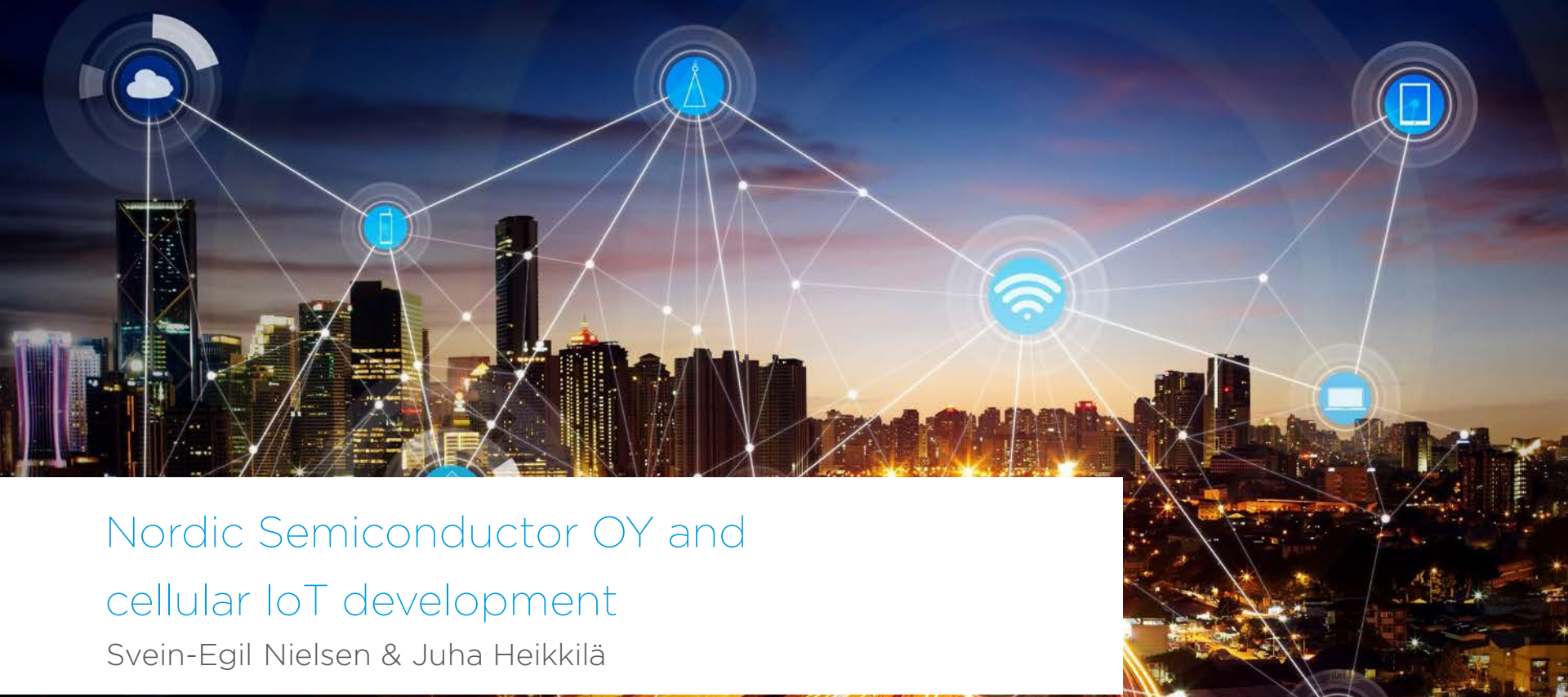
- Secure design wins
- Production ready and certified solution
- Help and drive customer production ramp

Mid-term (~2020)

- Surpass break even on a running basis; cellular IoT gross profits > cellular Opex on a running 12-months basis

Long-term (~2022 →)

- Significant contribution to Nordic total revenue and profitability



Nordic Semiconductor OY and cellular IoT development

Svein-Egil Nielsen & Juha Heikkilä

Fall of 2014 large technology layoffs in Finland

UUTISET > NEWS

News 23.7.2014 14:27 | updated 23.7.2014 14:27

Broadcom to stop making phone chips—600 jobs to go in Finland

The wireless modem maker Broadcom is to shut down its connectivity chip operations with the loss of 600 jobs in Finland. Some 430 of them will go in Oulu, which is already reeling from the announcement last week that Microsoft will close a research facility there.

Recommend 45 people recommend this. Be the first of your friends.

Image: Kirsi Karppinen / Yle

The fate of Oulu as an IT hub hangs in the balance after another company announced hundreds of job losses in the sector. Broadcom, a US wireless modem firm that runs a research hub in the city, is to cease operations in the connectivity chip field after failing to find a buyer for the unit.

The closure means 600 people in Finland will lose their jobs, with some 430 of those based in Oulu making "baseband" chips for mobile devices.

The northern city has been hit hard by changes in the technology sector, with some 500 people informed just last week that their jobs at Microsoft's research and development centre will go when the centre shuts down.

DATA CENTRE SOFTWARE SECURITY TRANSFORMATION DEVOPS BUSINESS PERSONAL TECH SCIENCE

Data Centre ▸ Networks

Ericsson follows Broadcom to modem Mordor

Swedes ring off

22 Sep 2014 at 13:36, Simon Rockman 0

Ericsson, once the major manufacturer of modems, is planning to leave the business. The move will see 1,000 redundancies and 500 people moving to other Ericsson projects, such as small cells.

In February 2009, Ericsson entered into a joint venture with ST-Microelectronics – itself a merger of SGS-Thomson and NXP – in a bid to take on Qualcomm. In mid-2013, ST-Ericsson was dissolved – with the modem business moving to Ericsson. The closure of the joint venture led to the loss of 1,600 jobs.

THE WALL STREET JOURNAL.

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EUROPEAN BUSINESS NEWS

Microsoft Layoffs Hit Finland Staff Hard

Country's Startup Culture Is Building as Rovi, Others Pick Up High-Tech Workers

Microsoft

NOKIA

By JUHANA ROSSI

0 COMMENTS

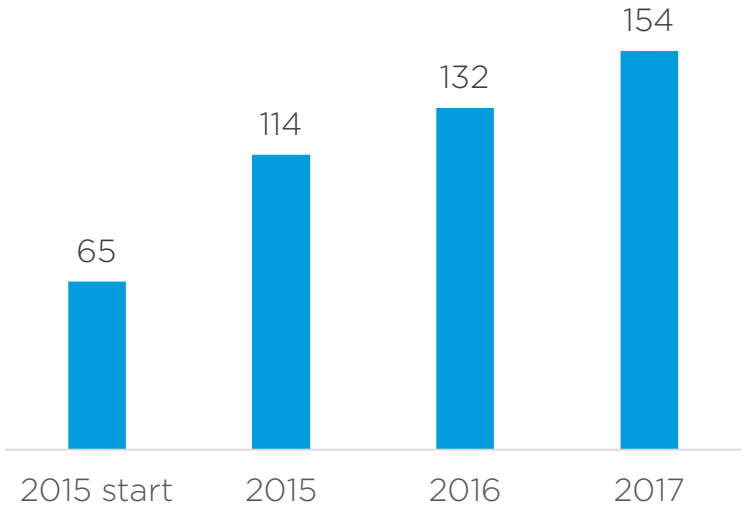
Travelled to Oulu to investigate and recruit opportunities

Ended up building a large R&D organization in Finland

Three Offices:

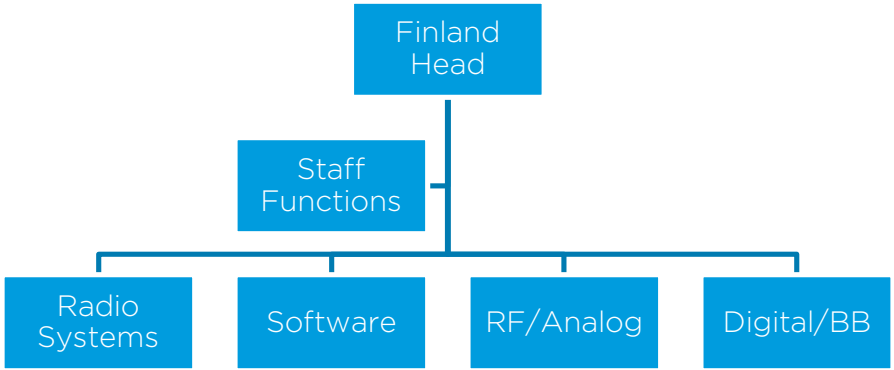
- Oulu
- Turku
- Espoo

Employees in Finland



Nordic Semiconductor Finland

Highly skilled organization



R&D Finland rapidly built up : Optimized for cellular low power and low cost IoT solutions develoment

Investments in addition to personnel:

- Design and Verification Flow (HW + SW)
- Pre-silicon Verification Platforms
- Extensive Analog and RF test laboratory
- Extensive cellular Protocol SW test laboratory
- Certification Testers
- Production Testers

Relevant experience

Radio Systems personell with Nokia-Renesas-Broadcom, Ericsson background

- Design experience from very first cellular systems up to high category LTE modems

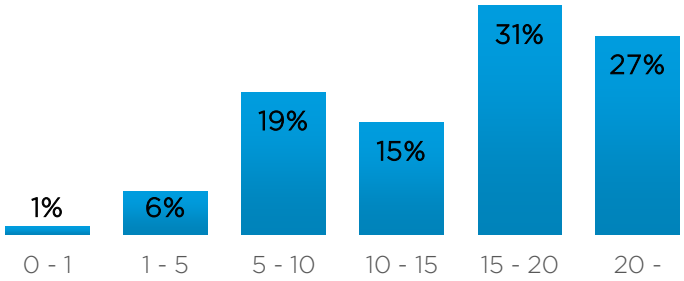
Power management, RF and Digital IC and SOC design personell with Nokia-Renesas-Broadcom and Nokia-ST Ericsson-Ericsson backround

- Multi-billion IC/SOC volume experience

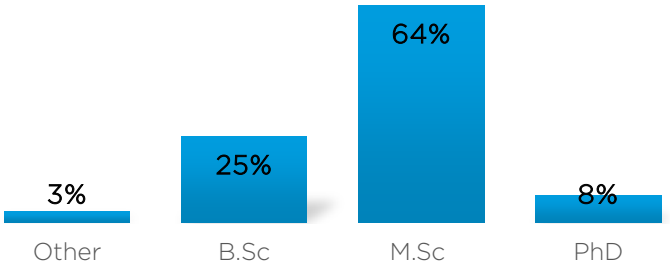
Firmware and protocol SW personnel with Nokia-Renesas-Broadcom and Nokia-ST-Ericsson-Ericsson background

- Multi-billion cellular product volume experience

R&D Finland Experience in Years



R&D Finland Education



Finland provides excellent opportunities for technology R&D

Finland's existing world class cellular engineering competences

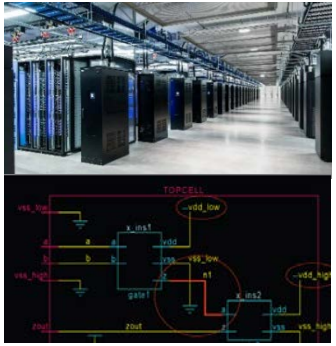
- Background from Nokia, Ericsson, Renesas, Broadcom chipset development
- Strong cellular chipset development ecosystem in Oulu (MediaTek, Altair, Nokia)

Education: University of Oulu, Aalto University, Tampere University of Technology

Strong government funding programs for 5G and IoT ecosystem boosts in Oulu. Even 6G program initiated recently.

Source:www.investinfinland.fi

Significant scale and resource sharing across Nordic Semiconductor organization



Scaling on existing infrastructure

- Technology Platforms
- Design and QA processes
- CAD tools
- Datacenter

Cross functional teams

- Development teams involved from across organization and territories
  - Scale on specialized skills
  - Ensure design reuse
  - Common processes and systems

Common technology and supply partners

- Existing suppliers such as; TSMC, ASE, AMKOR
- Technology partners, ARM

World class laboratory setup

- Pre-silicon modelling environments (IC emulation and FPGA) in place
- RF and Power measurement capability with high level of automatization
- Automated protocol testing capability
- RF Shielded champers
- Infrastructur vendor basestations
- Certification testing

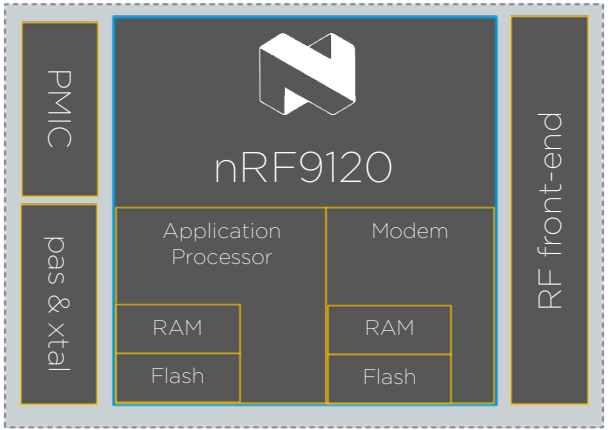
That's not all....we must lead on connectivity

Must have excellent radio performance and solid interoperability with carriers world-wide

- Develop and own the connectivity technology as a key differentiator for success; RF, Baseband, Protocol stacks
- Have global Multi-Band support
- Invest in interoperability through robust design, close collaboration with infra-vendors and carriers throughout development of the product
- Dedicated team for interoperability and certifications with carriers.

=> Achieve best in class Radio performance and interoperability similar to our position in Bluetooth

The development target was to make a product to disrupt the cellular IOT space



Achieve best in class power consumption for a cellular device targeted at IOT application

- Leverages Nordic Semiconductor's knowhow in low power from Bluetooth and proprietary 2.4GHz devices
- Build product from ground up with focus on low power – fresh new design – highly flexible software based architecture
- Use integrate memories and low-leakage process features

Make a developer friendly product that can enable everyone to make an cellular IOT product

- Leading edge application processor design with ARM M33, Trustzone and Cryptocell
- SDKs and toolchains shared with Bluetooth products
- Firmware upgrade capability on both application and modem
- Cloud enabled through nRFCloud
- Technical support through Nordic 24/7 support @DevZone

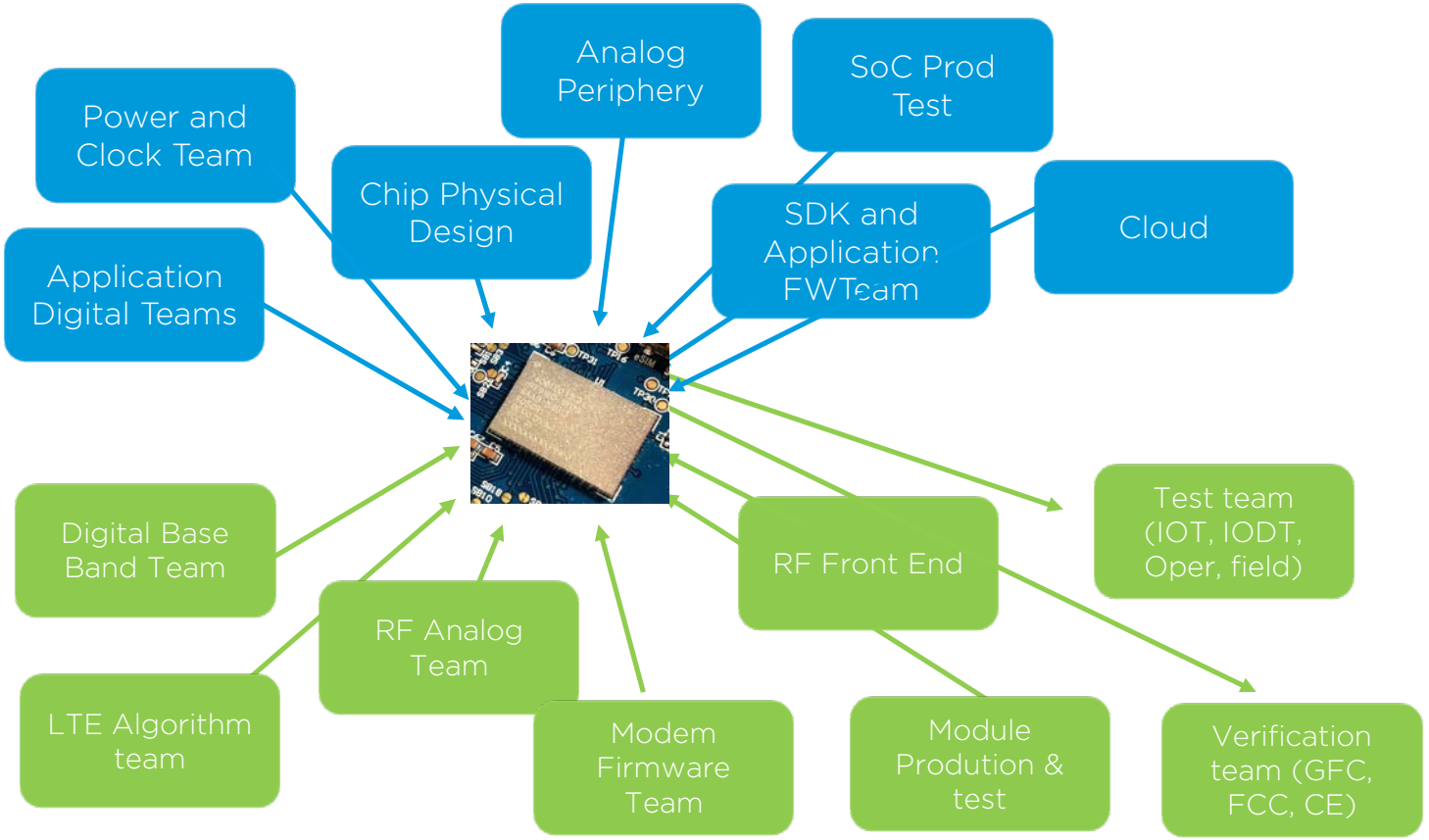
Ultra compact and small size

- Integrate and use advanced packaging techniques to reduce solution size

Using cross functional teams to develop

Common development with Bluetooth products

Cellular specific development



Tour of Facilities

Cellular made easy –
Cellular for everything else

Thomas Embla Bonnerud

Our unique approach to low power cellular IoT

By leveraging synergies with our existing and fast growing low power short-range IoT business;

- Deliver a highly integrated solution for connectivity and application
- Provide a superior ease of use and developer experience
- Apply a broad market engagement model

Complementary connectivity technologies

Low power short-range IoT

(Bluetooth, Thread, Zigbee,
802.15.4 and Proprietary RF)

(+) Local area connectivity; smart phones etc.

(+) Lowest power and smallest size

(+) Lowest cost and no subscription

Low power cellular IoT

(LTE-M and NB-IoT)

(+) Public network

(+) Coverage and roaming

(+) Quality of service, reliability and security

Solving different requirements and needs for connectivity

Similar markets – overlap and synergistic

Emerging and fast growing

Broad and diversified customer base

Across a broad range of applications

Consumer and non-consumer

Combining

Mixing

Market overlap and synergies

In terms of customer base and applications

Combining and mixing short-range and cellular

Cellular enabling new type of products and services

Different connectivity – similar application

Low power short-range connectivity

Low power short-range + cellular connectivity

Different connectivity for different needs

Cloud connectivity via short-range or directly with cellular
Short range connectivity for home network

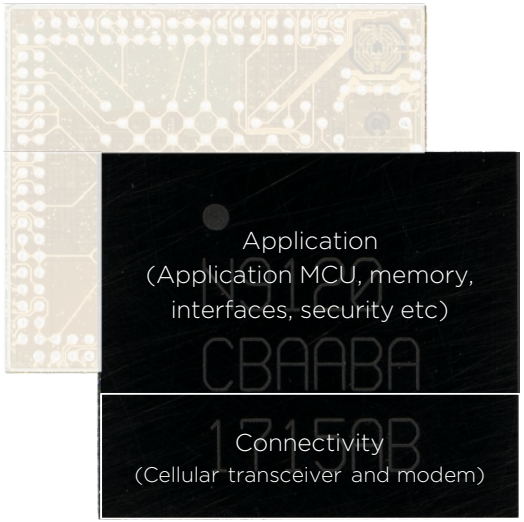
Similar application level requirements

Embedded processing, memory, interfaces and security
Application layer software and development tools

Alignment integrated solution

Between a low power short-range and cellular IoT solution
Different connectivity but similar application

Highly integrated solution



Cutting edge cellular connectivity

Developed by Nordic`s cellular team in Finland
Low power contribution from Norway

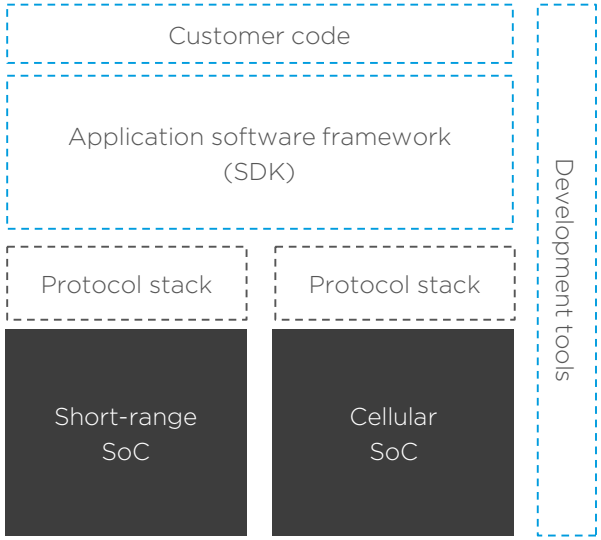
Common application platform

Across Nordic`s short-range and cellular products
Developed in Norway

Significant synergies

Application a big part of an integrated solutions
Common platform for software and development tools

Ease of use and developer experience



The two pillars Nordics ease of use

Complete solution – hardware and software
Great development tools

Leveraging a common platform

Application software framework and development tools
Developed in Norway and Poland

Mix and match for customers

Consistent and common experience across product lines
Lower barriers of entry for existing short-range customers

Broad market engagement model

Instrumental part of leadership in short-range

Sales, marketing and support organization

Developer community and distribution network

Leverage our organization for cellular IoT

Unique market reach in terms of cellular IoT

Drive innovation and adoption of cellular IoT

Leverage existing customer relationships

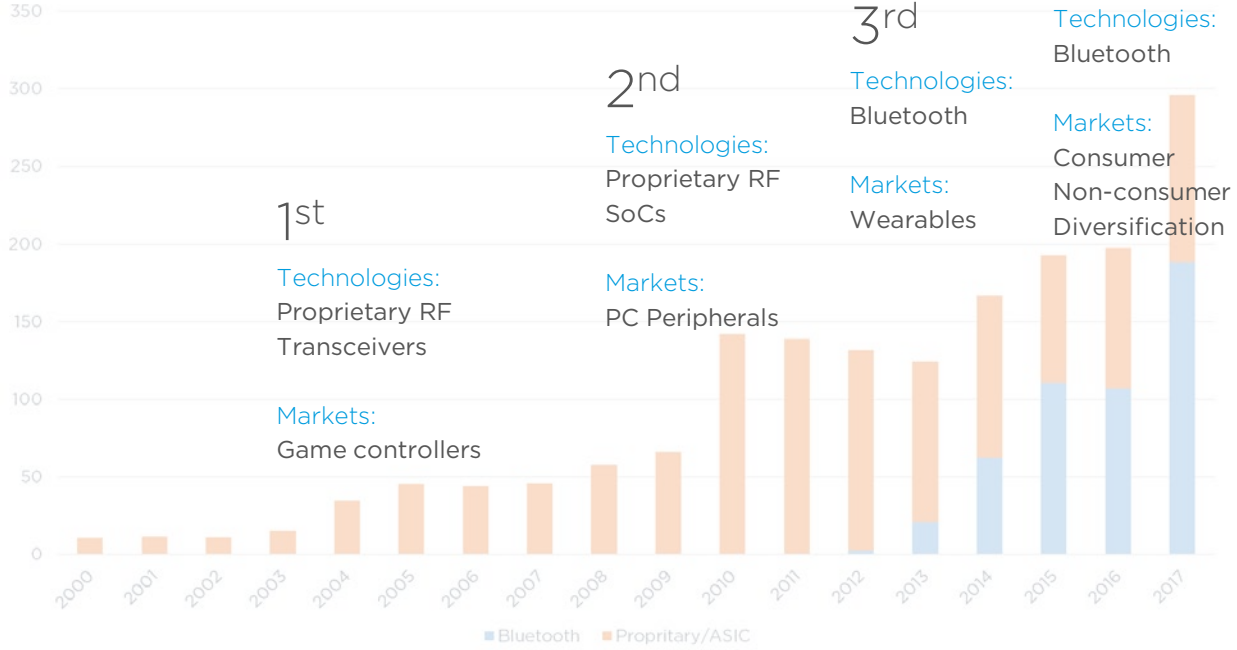
Customers expanding their offering with low power cellular IoT

Combining or mixing with short-range

Highly synergistic combination for Nordic

Low power short-range and cellular IoT

Cellular IoT to fuel our 5´th growth cycle



1st

Technologies:
Proprietary RF
Transceivers

Markets:
Game controllers

2nd

Technologies:
Proprietary RF
SoCs

Markets:
PC Peripherals

3rd

Technologies:
Bluetooth

Markets:
Wearables

4th

Technologies:
Bluetooth

Markets:
Consumer
Non-consumer
Diversification

5th

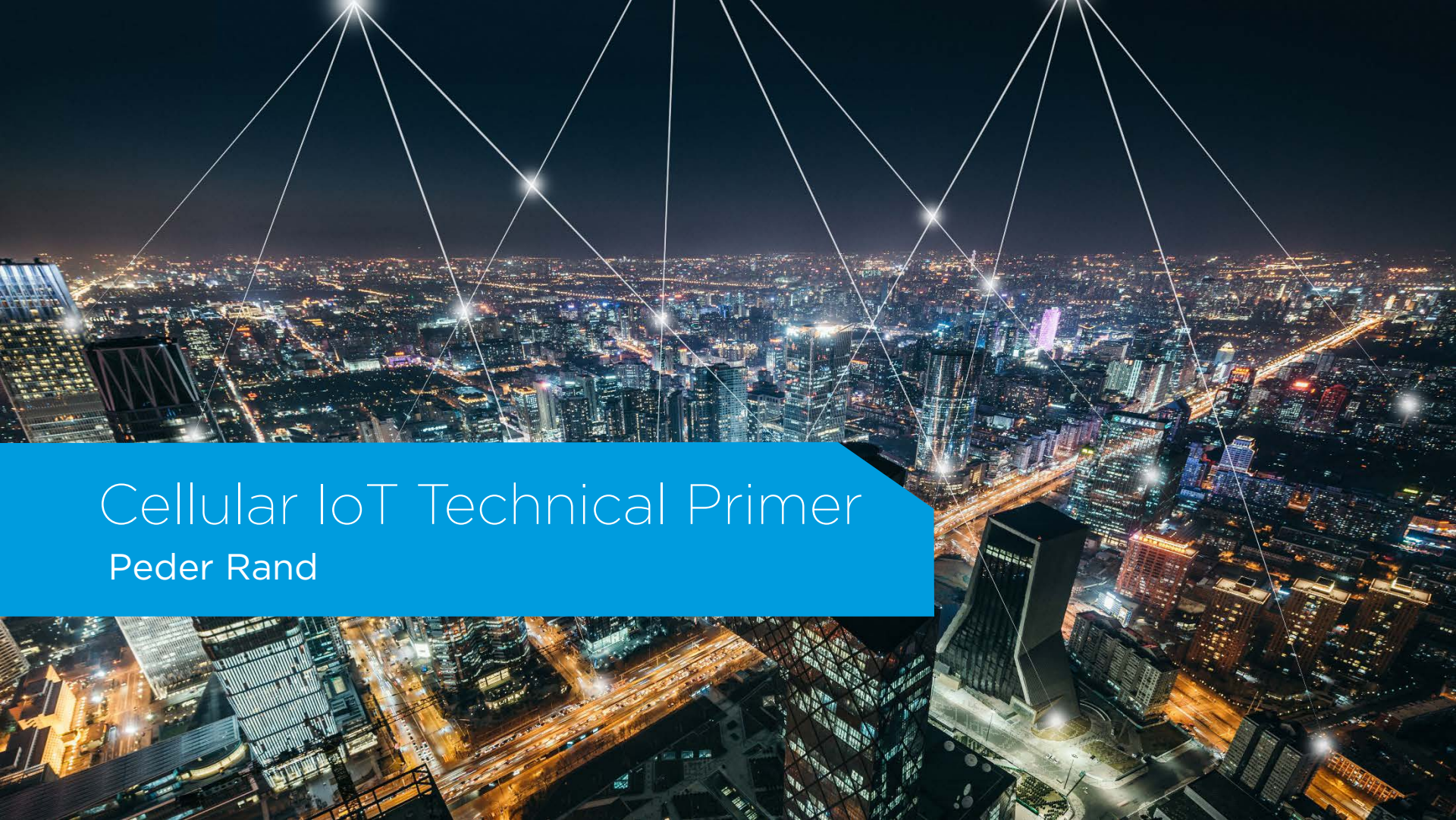
Technologies:
Low power short range IoT
- Bluetooth, Thread, Zigbee, 15.4, and Proprietary RF

Low power cellular IoT
- LTE-M, NB-IoT

SoCs and SIPs

Markets:
Consumer
Non-consumer
Diversification

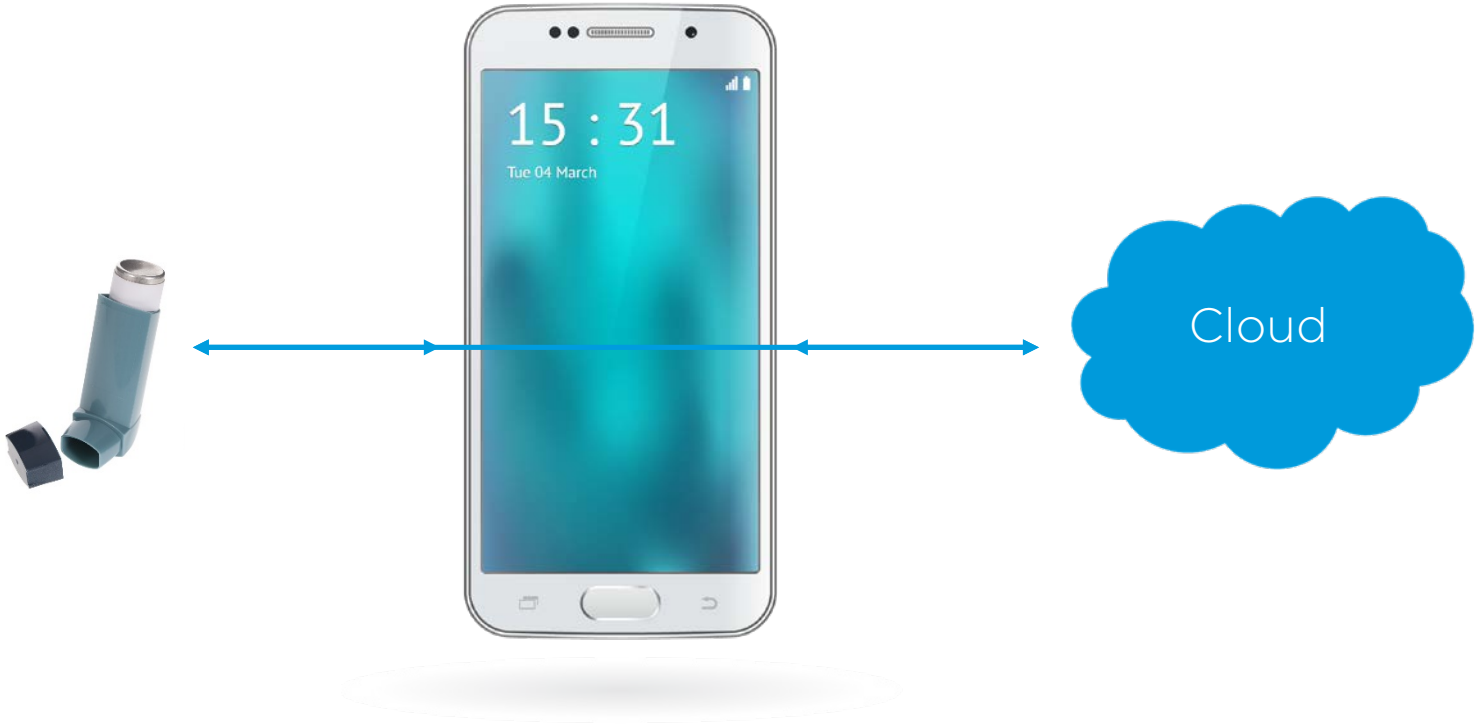
2018 →



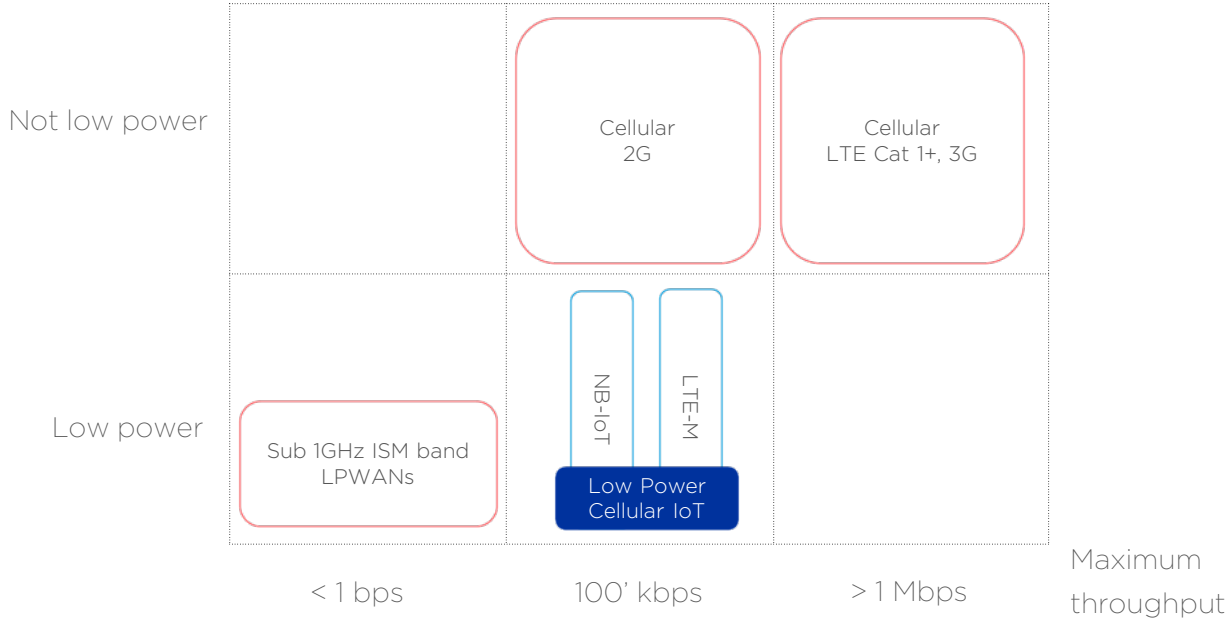
Cellular IoT Technical Primer

Peder Rand

Removing the $1000 IoT gateway



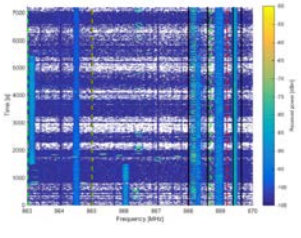
LPWAN technology landscape



LTE-M/NB-IoT vs. ISM-band LPWAN

Cellular IoT (cIoT) in Licensed band gives predictable Quality of Service (QoS)

- No interference
- Advanced protocol



http://vbn.aau.dk/da/publications/interference-measurements-in-the-european-868-mhz-ism-band-with-focus-on-lora-and-sigfox(4abbf909-e222-4a0c-aba7-63cc4ac43f60).html

Security is built into LTE

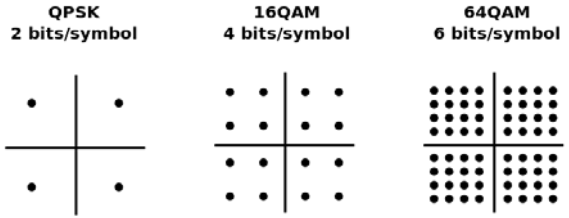
Connect directly to your cloud service

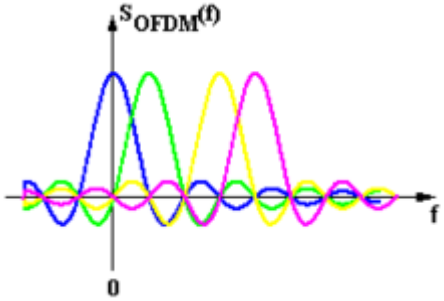
No very limiting regulatory restrictions on output power or duty cycle

New low power LTE technologies

	LTE-M	NB-IoT
Also known as	“eMTC”, “LTE Cat-M1”	“LTE Cat-NB1”
Max throughput	~ 375kbps	~ 30/60kbps
Range	Up to 4X	Up to 7X
Mobility	Yes	No
Roaming	Yes	Not yet
Deployment density	High	
Module size	Suitable for wearables	
Power consumption	Up to 15 years of battery lifetime	

LTE bandwidth





Wikimedia.org

How is the LTE BW achieved in your phone?

- Dynamic modulation QPSK, 16QAM, 64QAM
  - Changes depending on distance to base station
  - Can be different for uplink (UL) and downlink (DL)
- OFDM - Multiple carriers, up to 1200… 15 KHz apart…
- MIMO – multiple TX and RX antennas
- Full duplex in FDD (TX and RX at the same time)

How is LTE-M and NB simplified?

- Lower bandwidth
  - no MIMO
  - no 64 QAM
  - Few OFDM sub. carriers 6-72
  - Use half duplex communication

Managing range

QPSK, high Pout
Range Eext. mode B

QPSK, high Pout
Range Ext. mode A

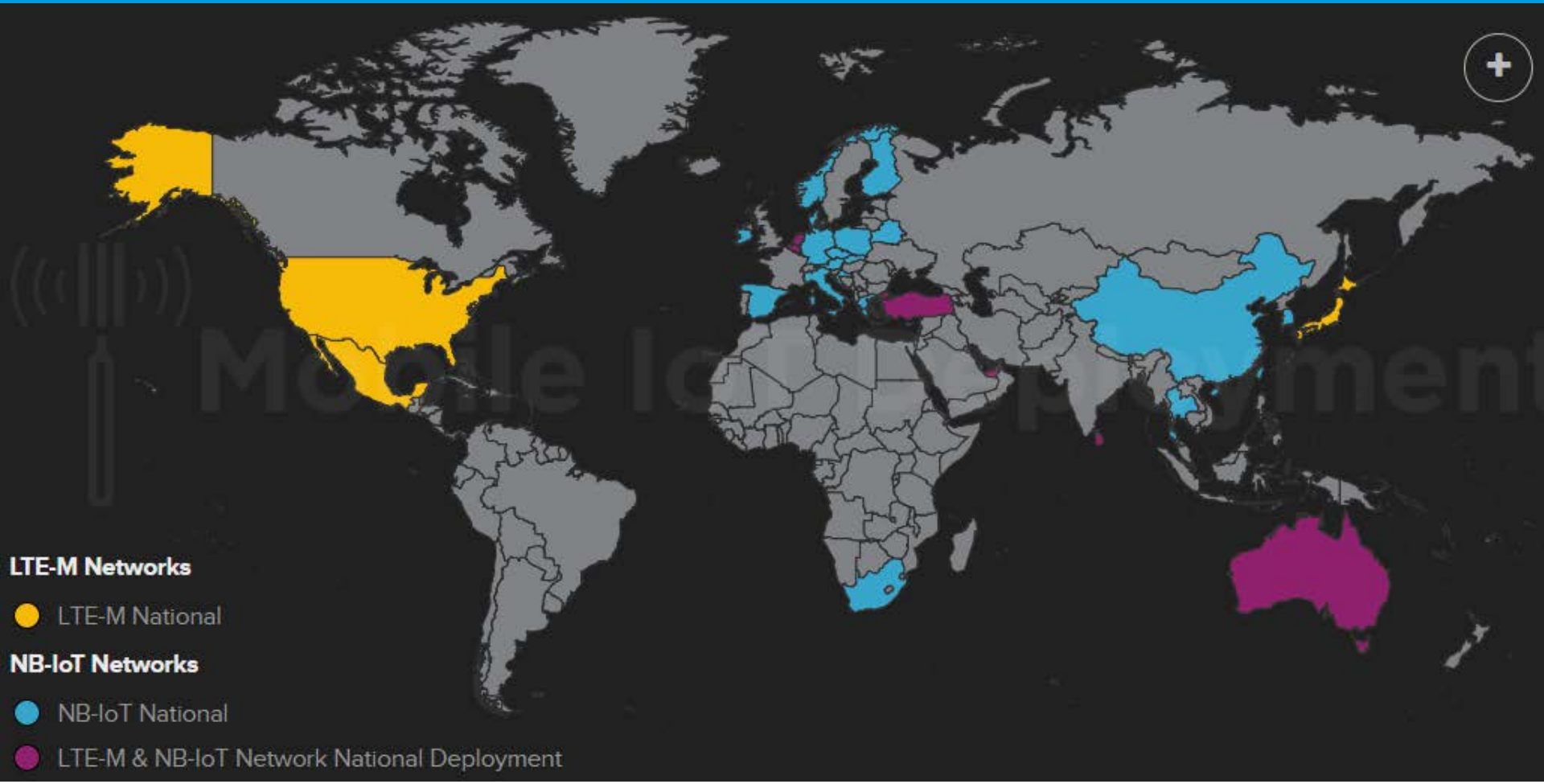
QPSK
High Pout

16QAM
Low Pout

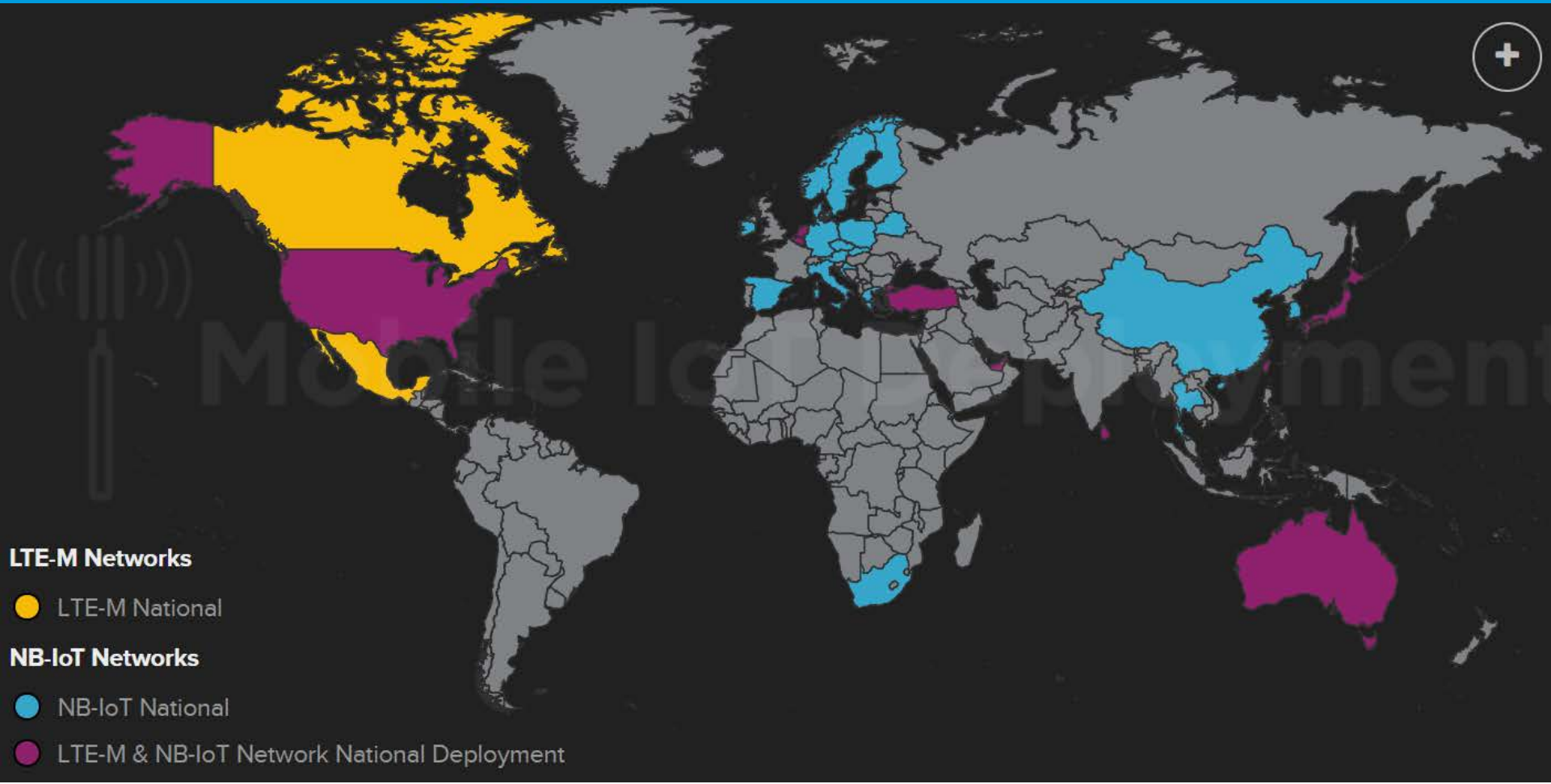
eNB decides output power, modulation and range extension mode for a connection

During a connection (RRC connected mode) decisions are made based on measurement reports from user equipement (UE).

In Idle and PSM mode UE attempts connection to strongest eNB (RSSI)



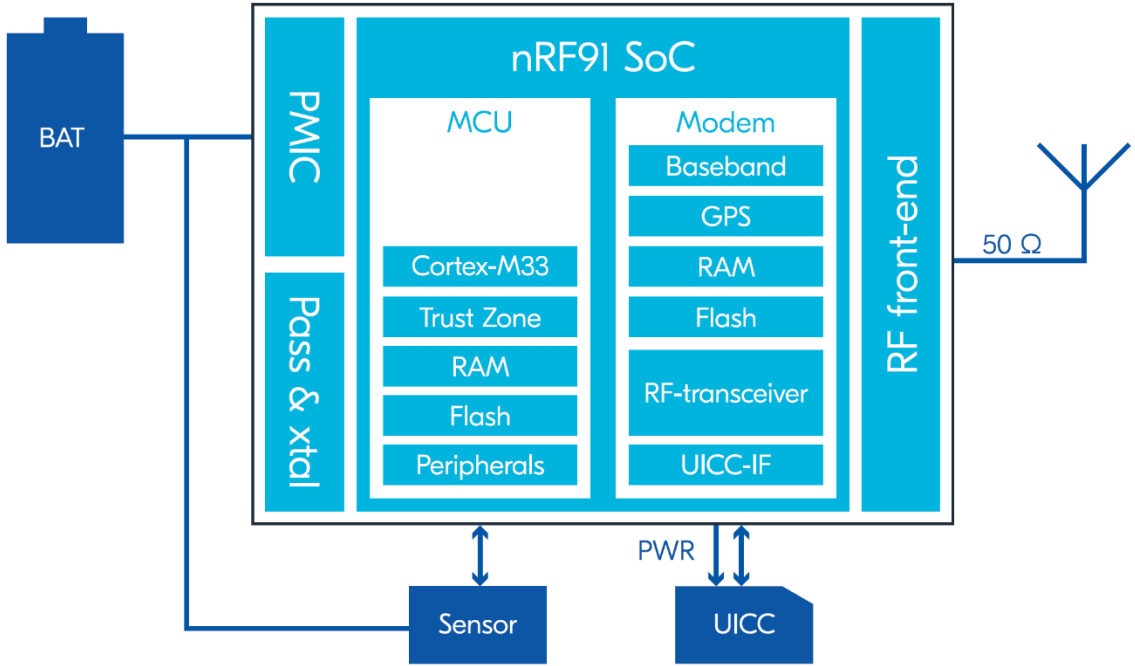
Source: GSMA.com June 2018



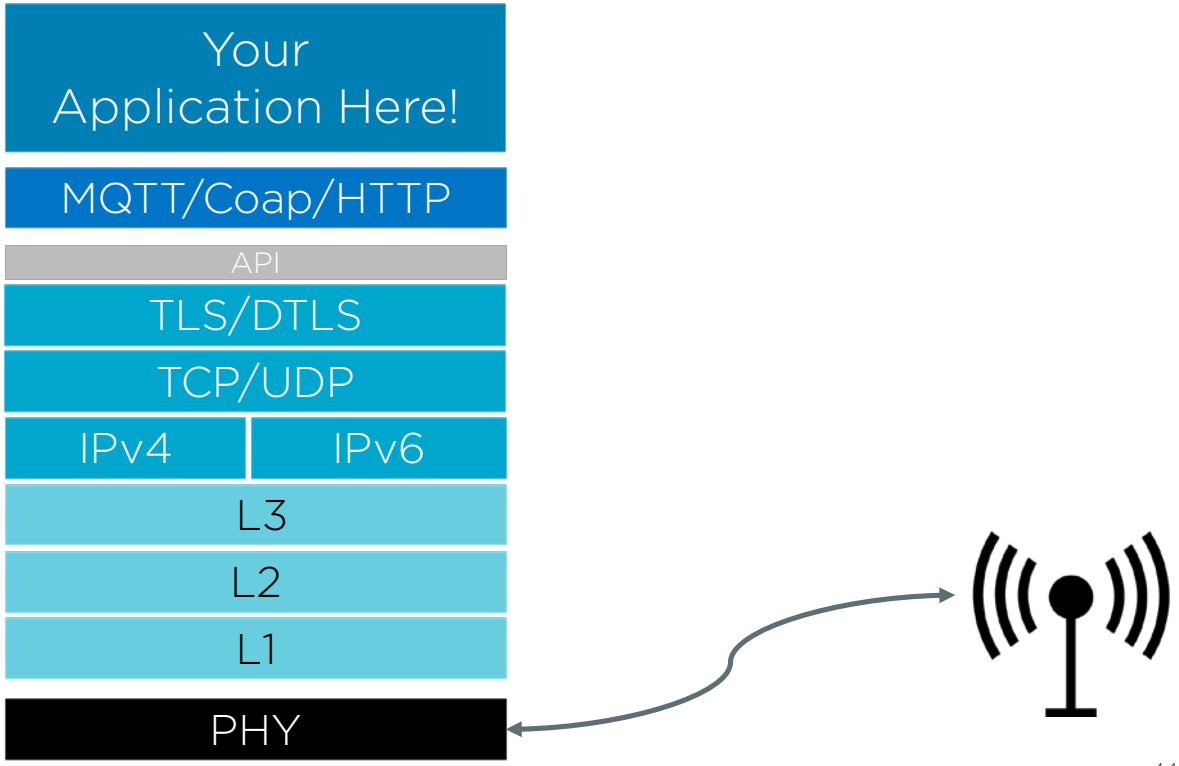
Source: GSMA.com August 2018

The Cellular IoT Device

Hardware Application Circuit



Data exchange



Application Level Protocols

ASCII-based machine-to-machine (M2M)/"Internet of Things" connectivity protocol

Publish/Subscribe model

TCP and TLS

CoAP

Constrained Application Protocol

REST model – GET, PUT, POST and DELETE

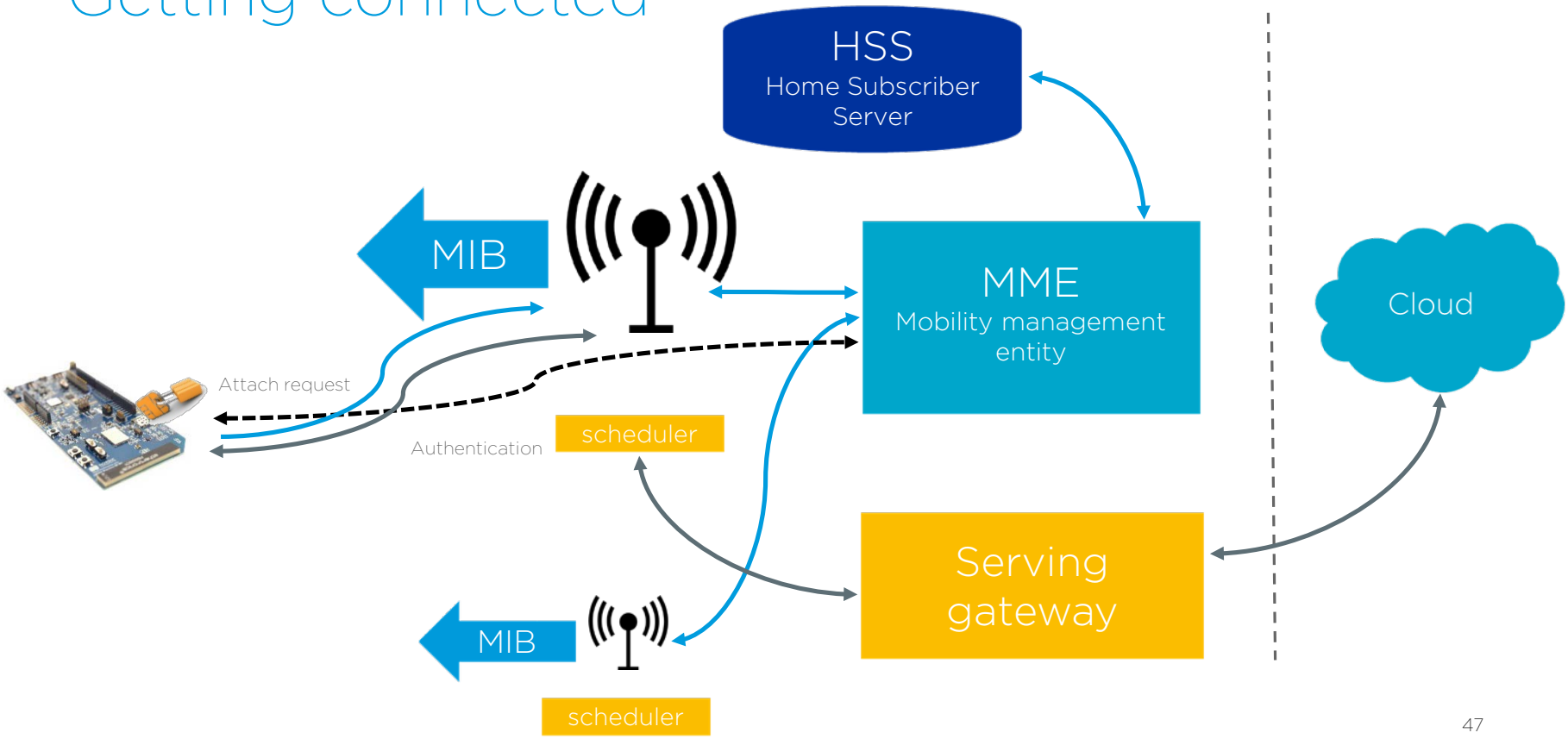
4-byte binary header

UDP and DTLS

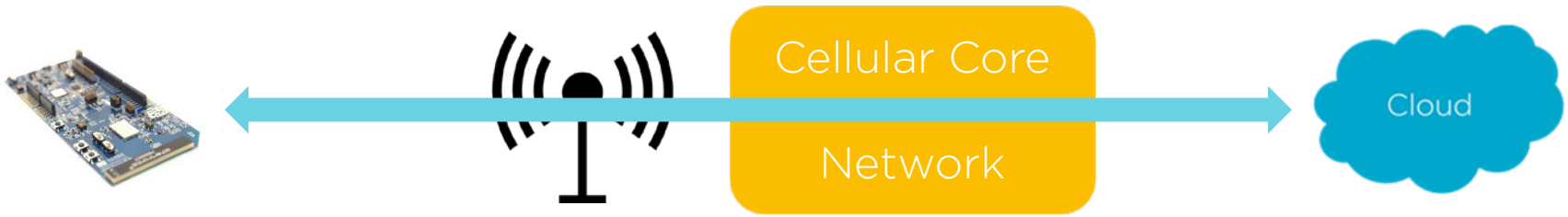
Getting Connected

Getting your device on the network

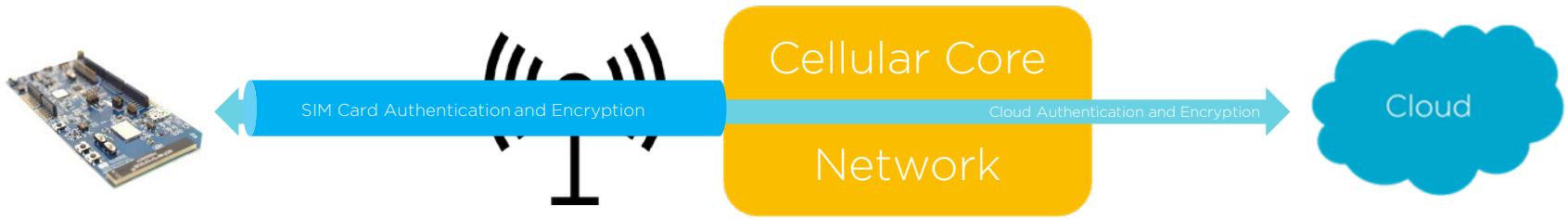
Getting connected



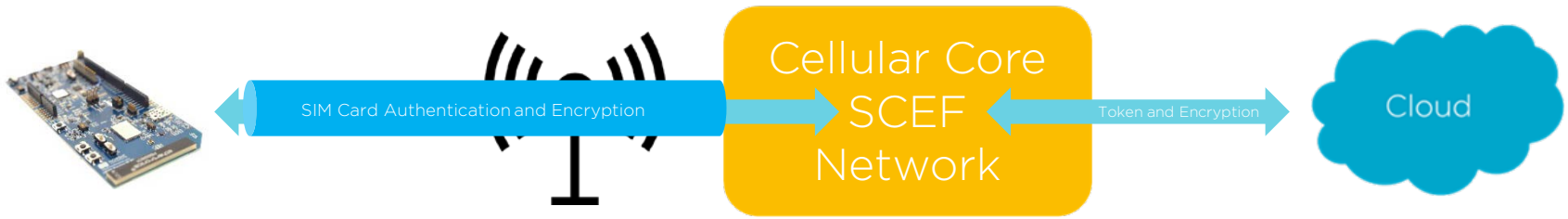
Data to the cloud



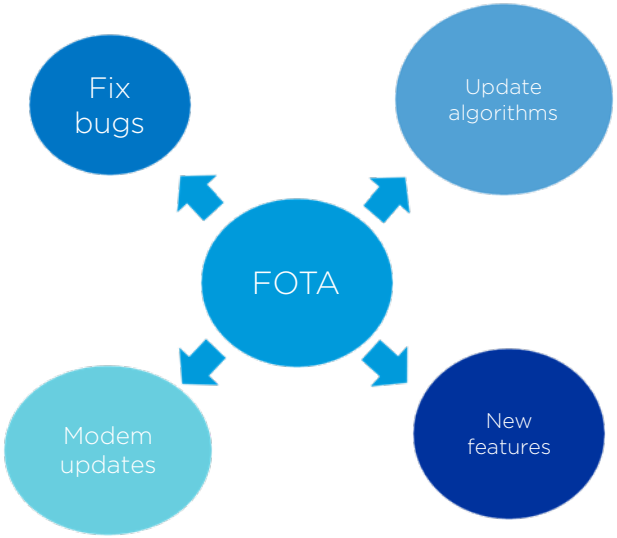
Security


SIM Card Authentication and Encryption
Cellular Core
Network
Cloud Authentication and Encryption
Cloud

Data to the cloud (indirectly)

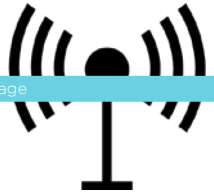


Flexibility and upgrades



10 years battery life is the goal, but....

- When will you find a bug?
- When will you find a security vulnerability?
- When would you like to upgrade performance or features?
- How long will your FW stay fresh and competitive?
- Update algorithms



Cellular Core Network

Cloud

Embedded Development

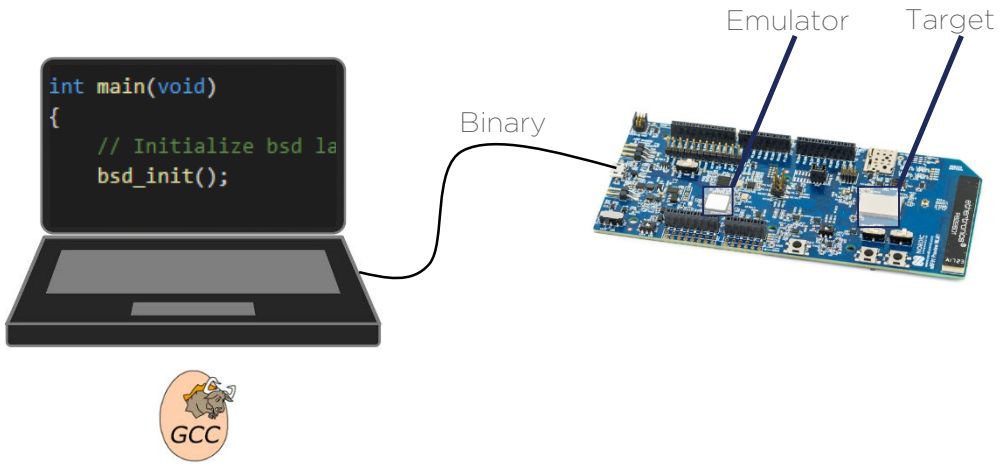
Challenges of IoT Embedded Development

#1 The target device does not have a screen or keyboard

#2 Restricted data and program memory

#3 Limited energy source

Embedded Development

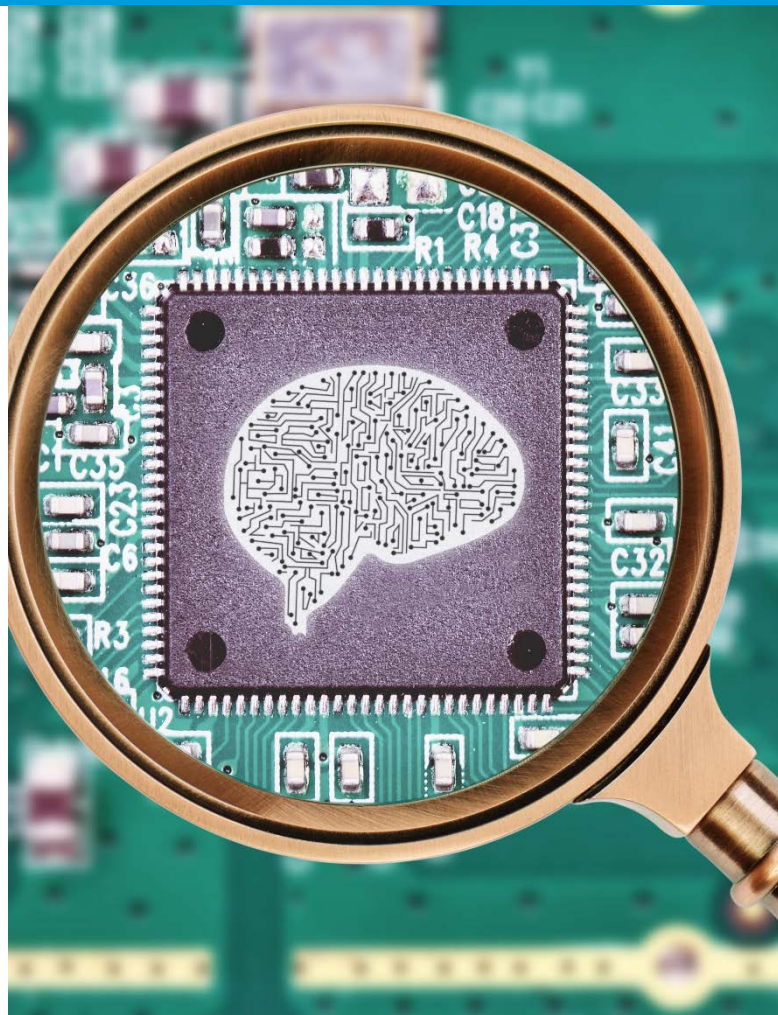


Edge Computing

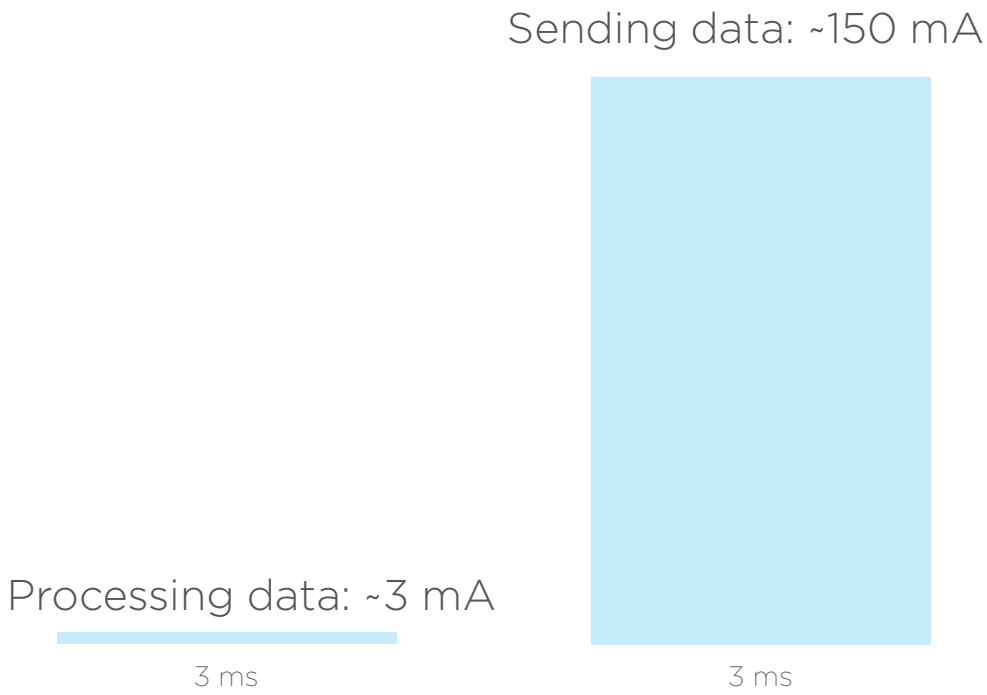
#1 Radio transfers cost energy and subscription fee

#2 Send information – not data

#3 When something interesting happens – then send data



The cost of sending data



What is a SIM card

- A secure microcontroller with hardware encryption/decryption capabilities
- It securely stores the subscriber identity and its associated keys who are used to;
  - Identify and authenticate subscribers on cellular networks
  - Generate the encryption key for the connection.

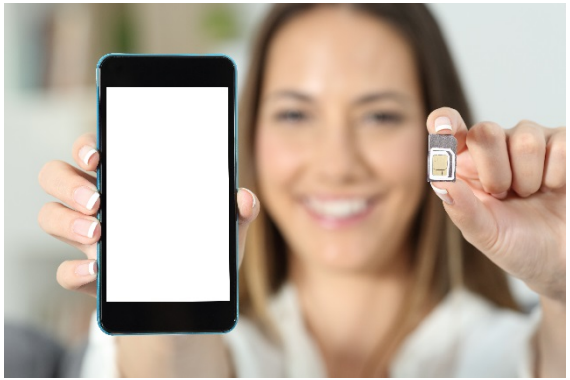
Motivation for having SIM cards

Functional features

- Subscriber identity – allocate cost of use to the right subscriber
- Encryption key exchange between base station and user device
- Separation between user-configurable modem software and the operator controlled SIM
- Method for distributing identity, key pairs to manufactured products

Non-functional features

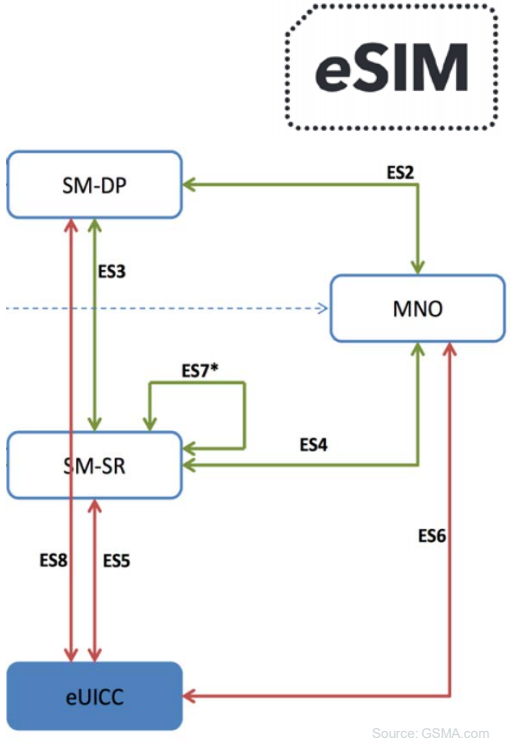
- Physical manifestation of carrier relationship with the customer – the carrier supplies the SIM card



M2M eUICC

- Often referred to as eSIM
- Can be implemented in pluggable or solderable hardware
- Implements interoperable GSMA specification for remote profile switching and loading
- Has one bootstrap profile that allows initial connection
- Connects to a server (SM-SR) through which the owner of the device can remotely choose which profile to use, update or delete profiles

- Gives device owners security in case of changes in the operator's situation and negotiating power as they have a real option to switch



Expanding the cellular IoT

- Edge nodes on coin-cell batteries
- Use ultra-low power protocols like
  - Bluetooth Low Energy
  - ZigBee
  - Thread

- Gateway on larger lithium cells
- Central/coordinator for local network
- Use LTE-M for cloud-connectivity

Summary

1 Cellular IoT will give ubiquitous and low power cloud access to things

2 LTE-M for mobile devices with medium data requirements

NB-IoT for stationary devices with low data requirements

3 Send Information, not data – except when something interesting happens

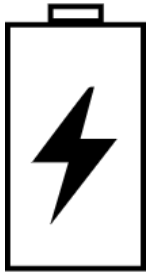
SnowBot is connected to the cloud https://lefthandrobotics.com/product/

Nordic cellular IoT Offering

Peder Rand

The nRF91 Advantage in cIoT

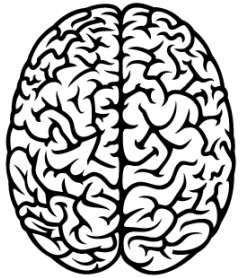
Low Power



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

Simplified customer engagement model

Traditional model

Chipset supplier → Module supplier → Customer

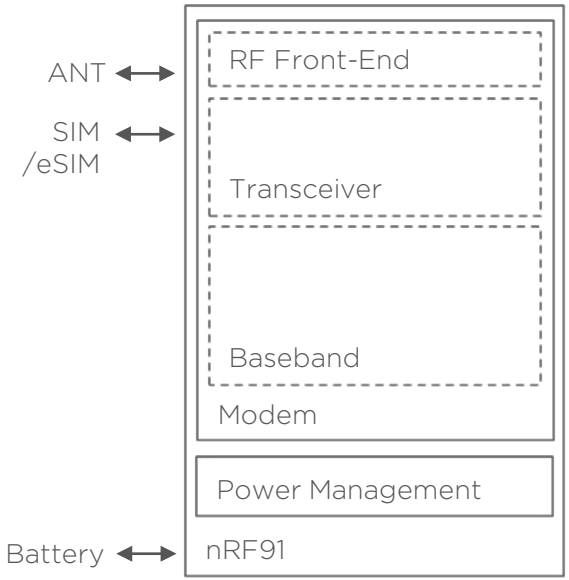
- Module supplier does value add integration and solutions
- Module supplier often handle sales, marketing and support

Nordic model

Nordic → Customer

- Nordic is one-stop shop for Cellular IoT
- Building on Nordic's proven broad market engagement model

Low power cellular connectivity made easy



Complete modem in a package

Multimode LTE-M / NB-IoT

All the benefits of a traditional module

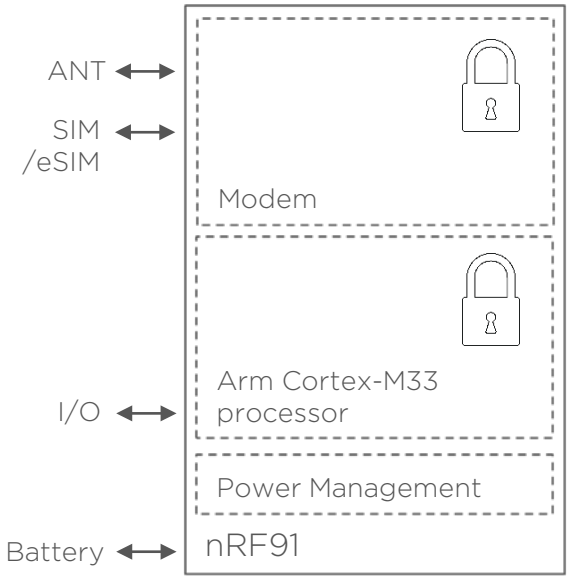
Ease of integration and use

Teleregulatory, standard and carrier certifications

Global operation with one variant

Multiband support for world wide coverage

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

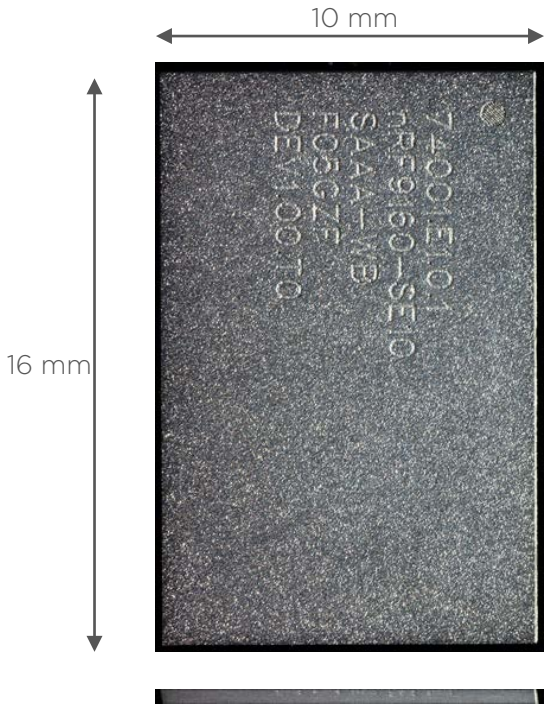
Root of trust and trusted execution environment

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

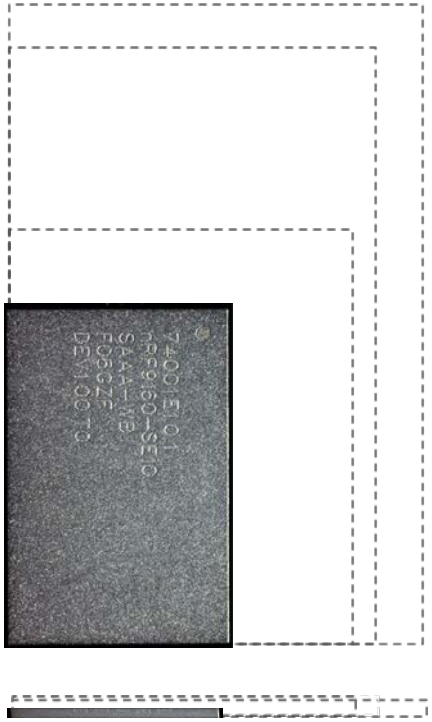
Built-in global RF Front-End and shield

Qorvo custom RF Front-End and MicroShield™ technology

Ultra-compact form factor

10 x 16 x 1 mm

New industry benchmark on solution size



Up to 3x

smaller footprint

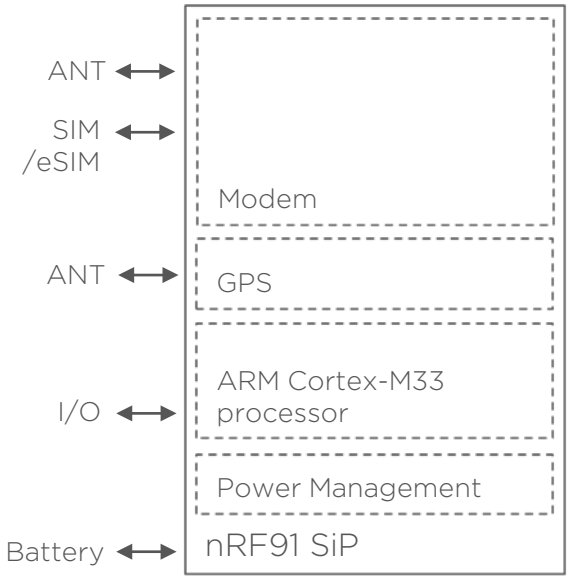
Up to 2x

thinner

Up 5x

less volume

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

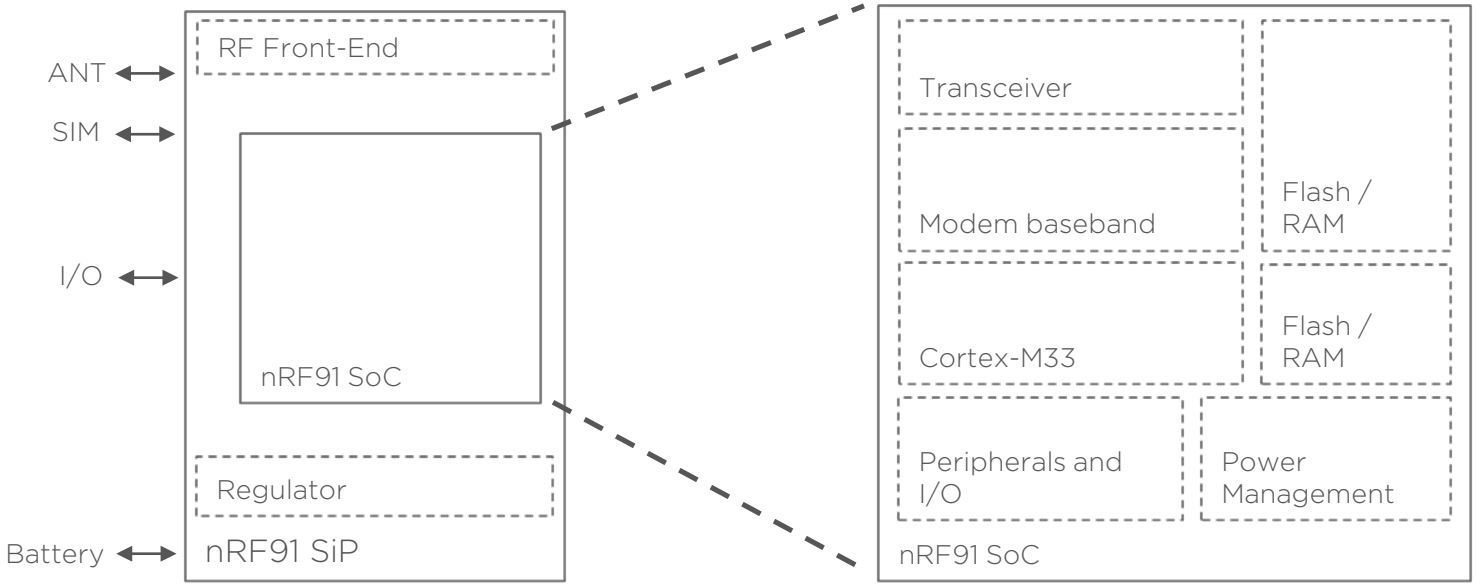
Combines cellular and GPS position data

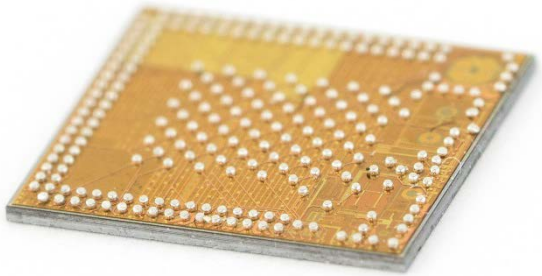
Power Consumption

~ 15 uA	~ 0.5 mA	~ 150 mA
Connected with 10 minutes downlink latency (eDRX)	Sending tracking information every 20s (DRX)	Downloading new firmware @ 360 kbps (RRC Connected)
More than 15 years battery life	More than 6 months battery life	A 512 KB image updated in 30 s

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

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

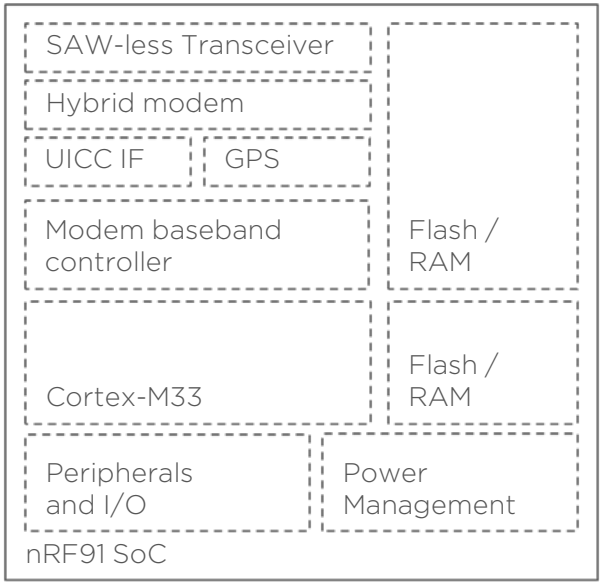
Tight integration

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

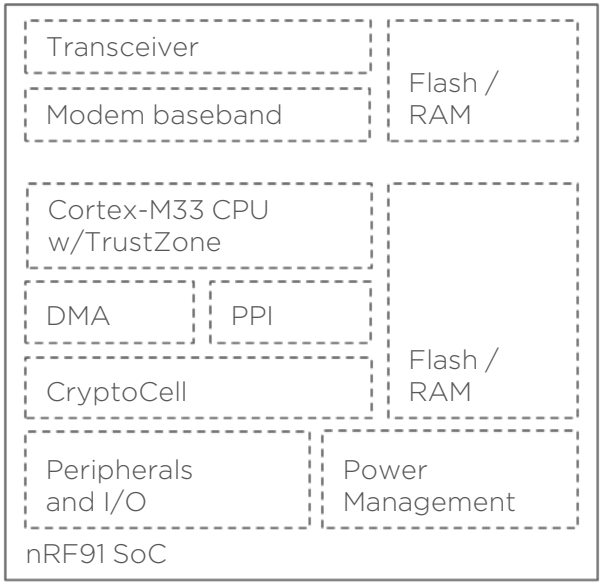
No memory loading

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

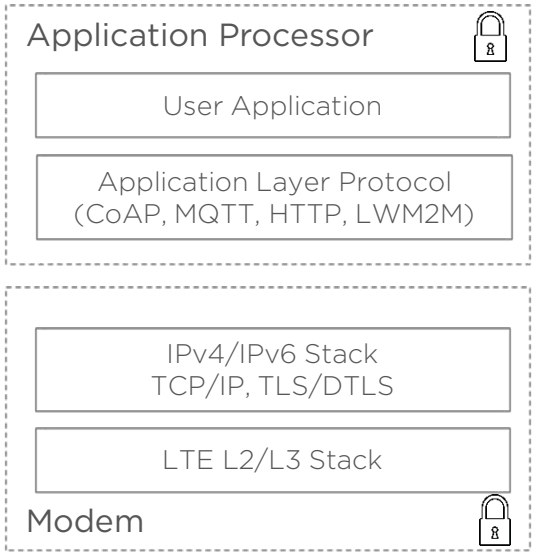
Powerful Peripherals

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

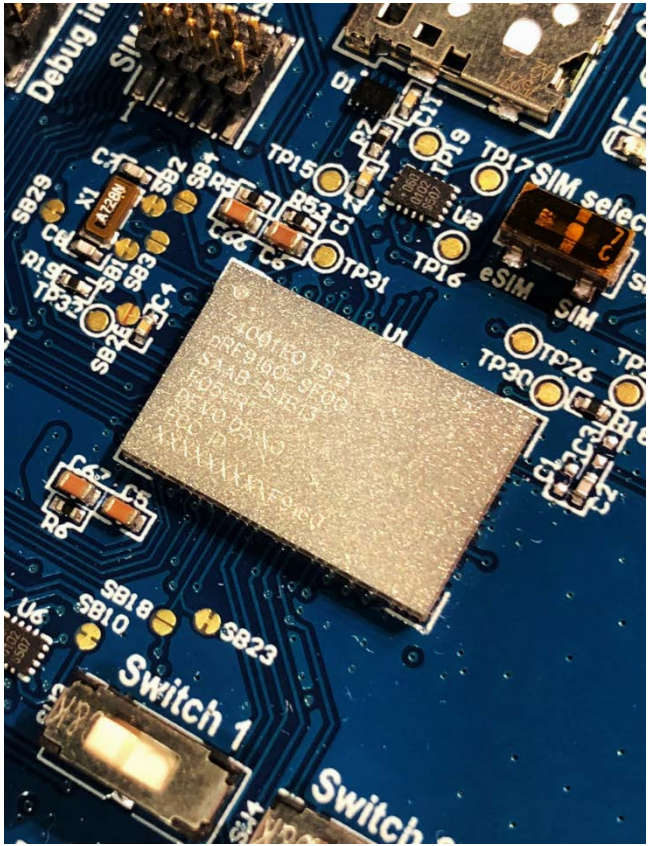
Our Software



Full application development SDK

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

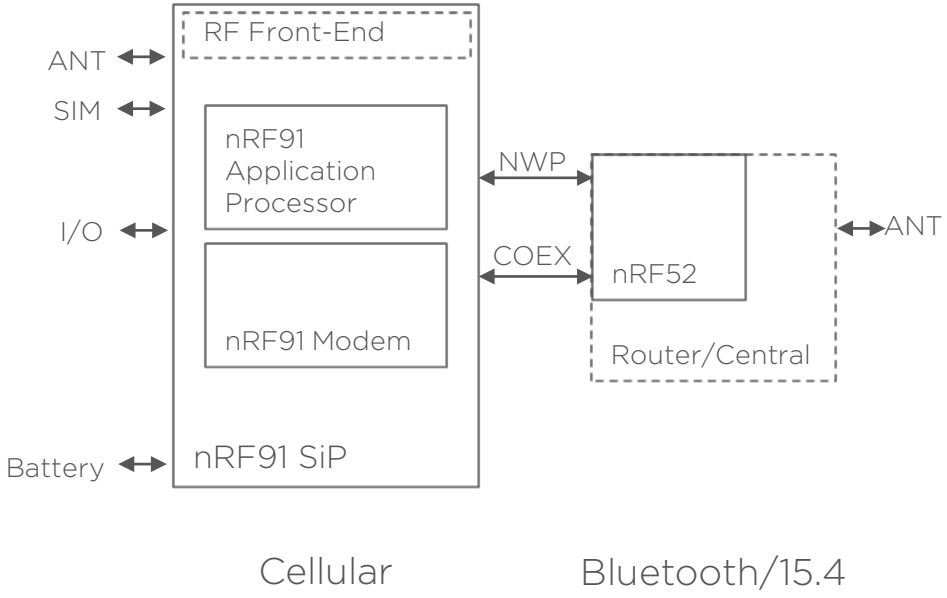
Comprehensive sample applications



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 50Ω 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

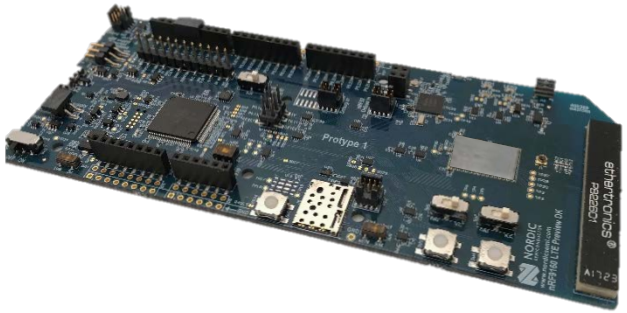


Chipset approach

Automatic coexistence interface

Software drivers and sample application in the SDK

Easy to use development kit



ARM debug and trace on-board

Wide band antenna for world-wide operation

Supports Arduino Uno Shields

Bluetooth on-board

Unique value proposal with nRF91 SiP

Size and power consumption

- Industries smallest and lowest power solution
- A “no compromise” attitude to performance

Value add integration and features

- Application processor and Assisted GPS
- Global operation and advanced system level security

Solution completeness and ease-of-use

- Software and development tools; including cloud
- Nordic support and developer community

Demo time

Demos

- Demoing nRF91 production silicon
- Using internal development boards for demo
- Showing
  - CAT-M1 data transfer live network
  - NB-IOT data transfer live network
  - GPS

Certifications

Svein-Egil Nielsen

Nordic's nRF91 needs a number of certifications

Requirements and processes

- Overview of what certifications are needed for nRF91
- How we develop the product to ensure certifications success
- Certification process
- Progress

Certification is a permission to sell a product, it is not a guarantee of a great product

nRF9160 Certification Overview

Type approval and country specific certifications (Regional regulatory)

- Main regulatory certifications: CE (Europe), FCC/ISED (USA and Canada)
- In addition, there are some country specific regional certifications e.g. TELEC (Japan) ACMA (Australian), KCC RRA (South Korea), IMDA (Singapore), SRRC RTA and CCC (China), ...
- Regional regulatory certification is required for all products in the market

GFC certification (Global Certification Forum)/PTCRB

- GCF/PTCRB Certification demonstrates that devices conform international standars for mobile technologies, 3GPP, and interoperate with networks worldwide
- GCF/PTCRB Certification is required for all devices incorporating mobile connectivity

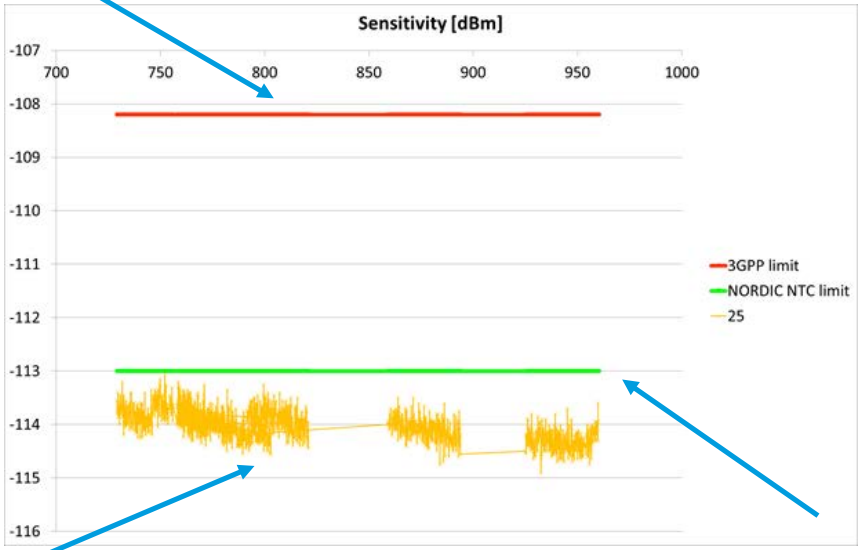
Carrier approvals

- Certain operators require their own approvals for products to operate in their network to ensure product will meet their specific requirements
- In many regions and with many carriers no carrier specific certification is required

Certification and interoperability drives development from the start (I)

EX: RF design

Specification limits



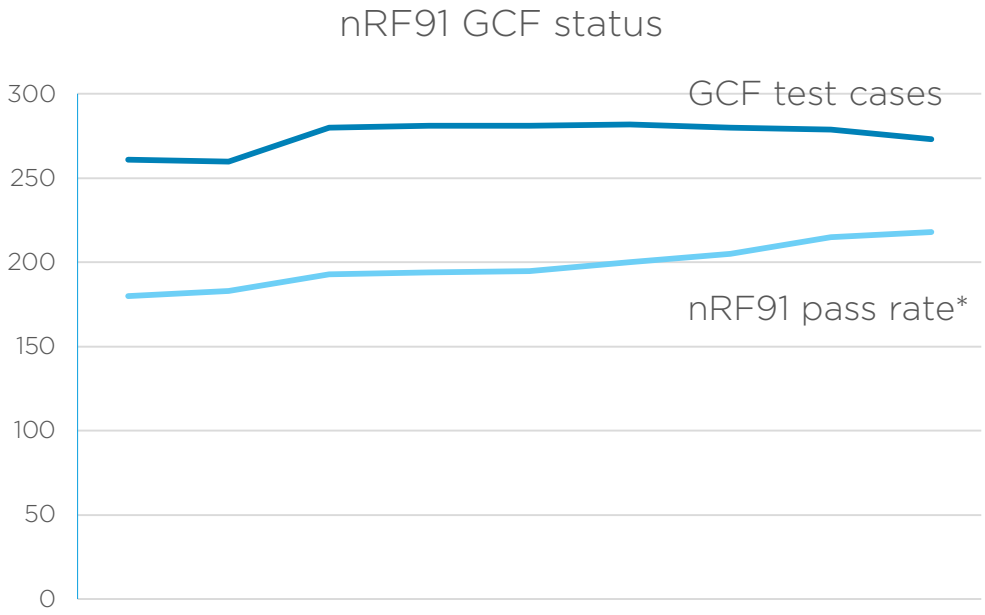
Actual results from measurements

Design acceptance limit

- From the start of design, design targets (parameter limits) are driven by the need for great interoperability and to pass certification
- We typically have much stricter requirements than certification and specification limits
- Limits are set by teams that have significant cellular experience

Certification and interoperability drives development from the start (II)

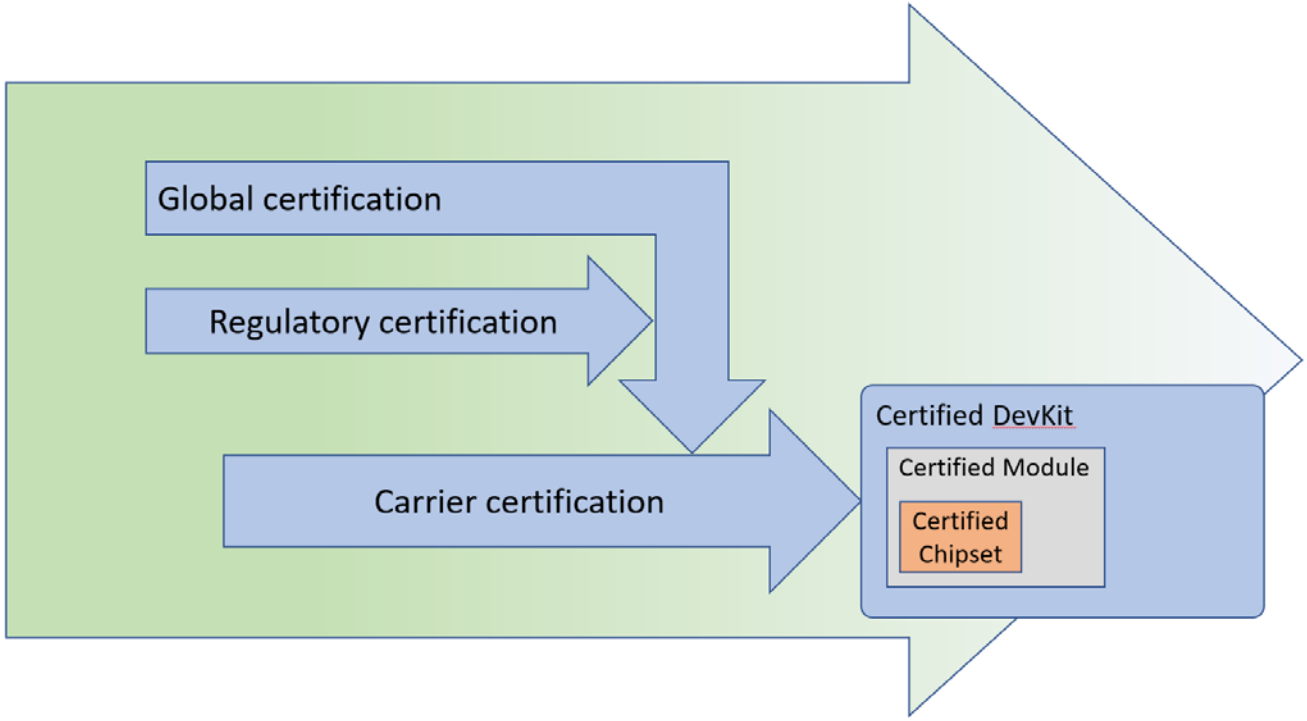
EX: Software design



- We continuously test software toward specification and certification requirements to ensure maturity and prevent regression
- Software builds are also continuously tested with infra-vendor equipment and in live networks (field trials)

*Pass rate affected by inability to test all test cases with existing equipment

Current certification process with final silicon



Certification progress and targets

Collaboration with main infrastructure vendors

- Interoperability testing (lab and field testing) have been ongoing both in inhouse basestations and in infrastructure vendors labs

Regulatory certifications (e.g. CE, FCC)

- Pre-certification tests passed for selected bands
- Actual certification projects starting with final silicon

Global certification (GCF)

- Significant number of GCF test cases have been run on approve test equipment
- Full set of GCF test cases can now be run on newly installed equipment

Carrier certification

- Pre-certification testing passed for initial sampling in selected carrier labs
- Field testing ongoing in several territories
- Carrier certification projects ongoing

Target to have GCF/CE/FCC in place during 2018

Customer Sampling

Peder Rand

Cellular IoT Applications

Diverse Markets & Application

Asset tracking

Healthcare

Wearables

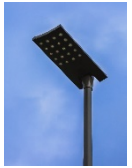
Metering

Location
Condition
Sub-units

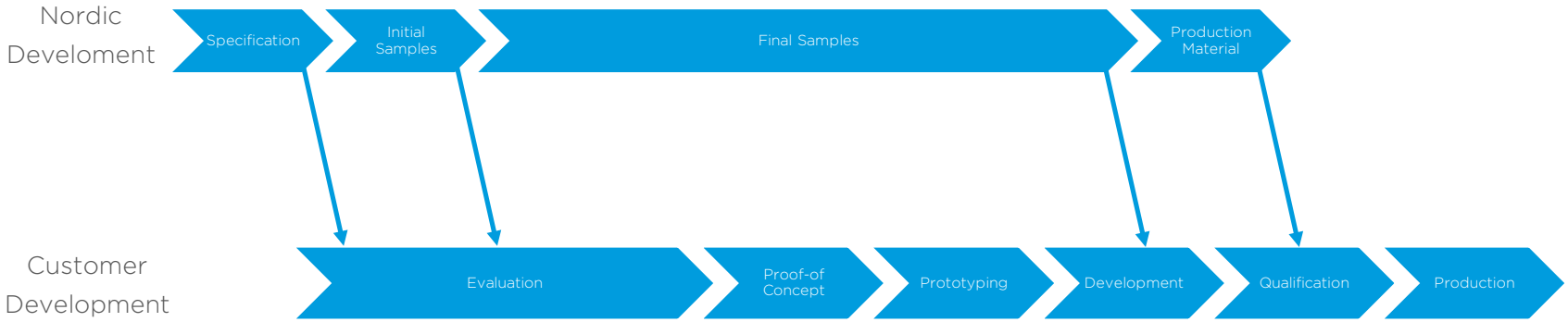
The patient should not be the network operator

Leverage existing infrastructure
Great coverage and scalability

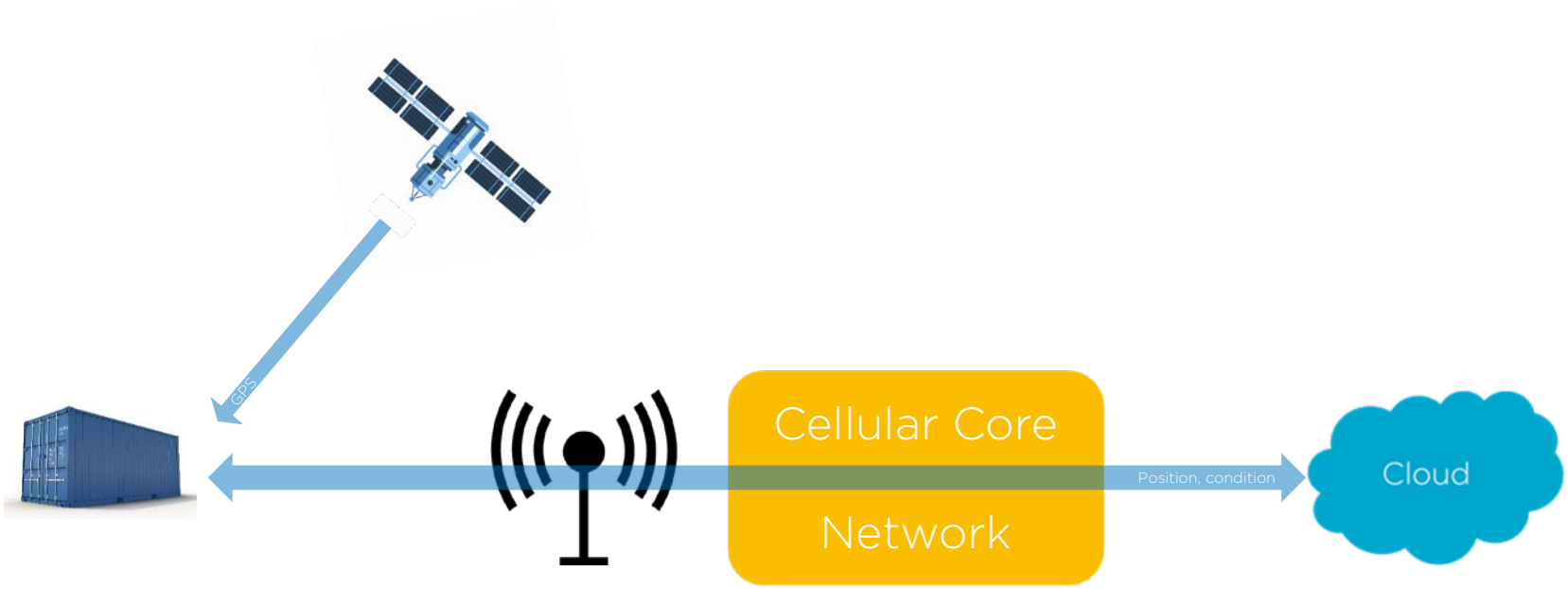
Garbage Bins
Street lights
Sharebikes
Smart Parking



The power of early sampling



Case Study – Asset Tracking



The Challenges

- Will it know where it is?
  - Efficient GPS antenna solution
  - Indoor positioning?
- Will it be able to communicate with my cloud service?
  - Cellular subscription coverage for the relevant area
  - Range, range, range
- Will the battery life be sufficient?
  - Match maintenance cycles?

The Challenges

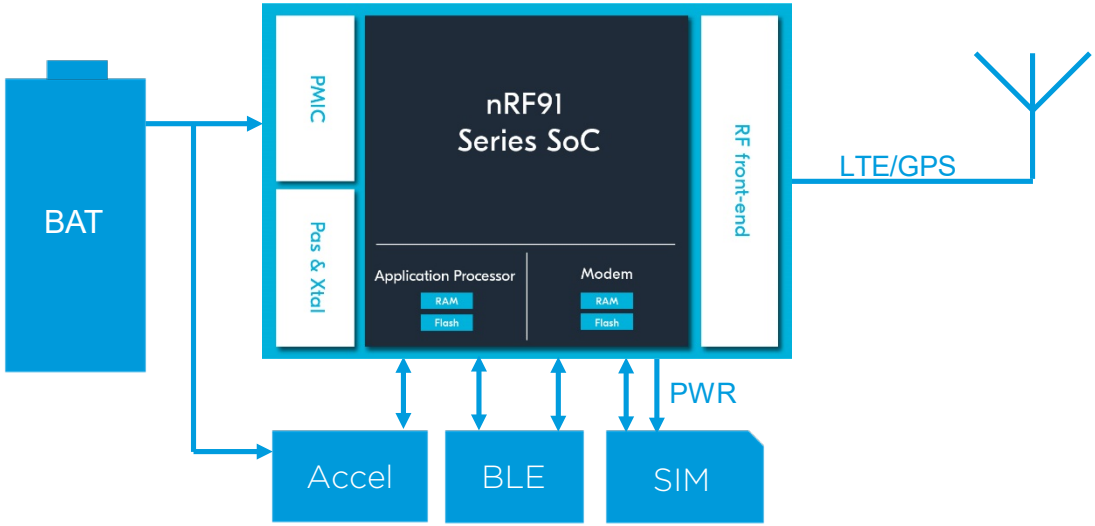
- Should it be capable of tracking smaller items around it?
  - Use BLE or other simple protocols
- Will it be cheap enough to manufacture and use?
  - COB, cellular subscription, cloud solution
- Will it be manageable?
  - Firmware upgrades, comissioning, decomissioning

The Evaluation of LTE-M and NB-IoT

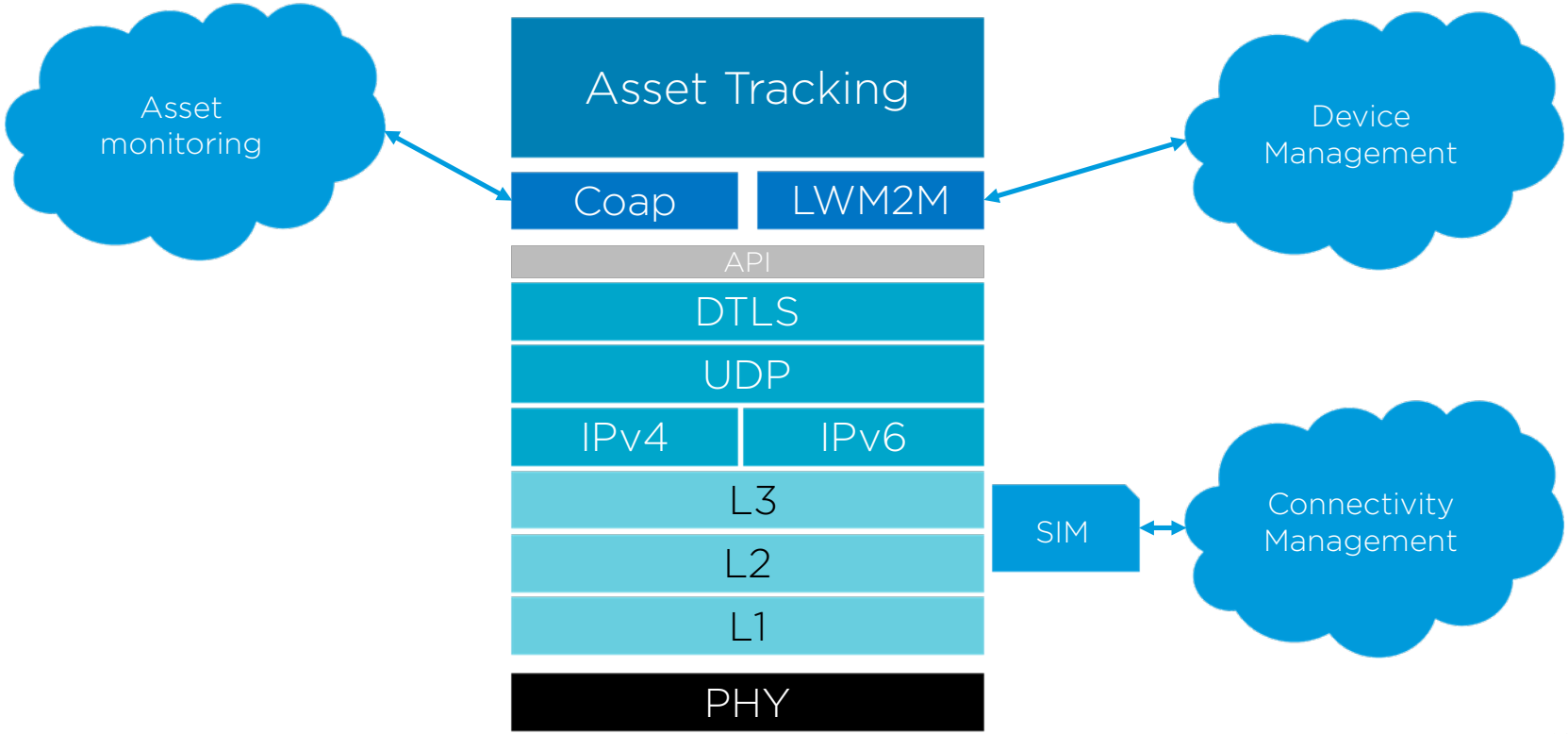
- Can our challenges most efficiently be solved with LTE-M or NB-IoT for long-range communication?
- How do the different suppliers stack up against each other?
  - Power Consumption
  - Application development support
  - Size
  - Production capacity and quality
  - Solution cost

The HW product

- Development kit – reference design



The SW product



Support and Community

Chip, firmware, SDK, module all developed and supported by Nordic!

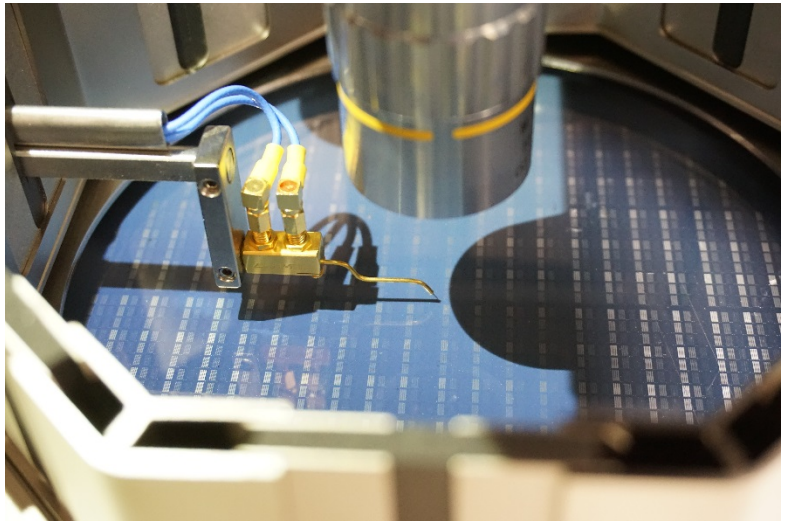
Nordic DevZone
Engineer-to-Engineer
& Technical Support

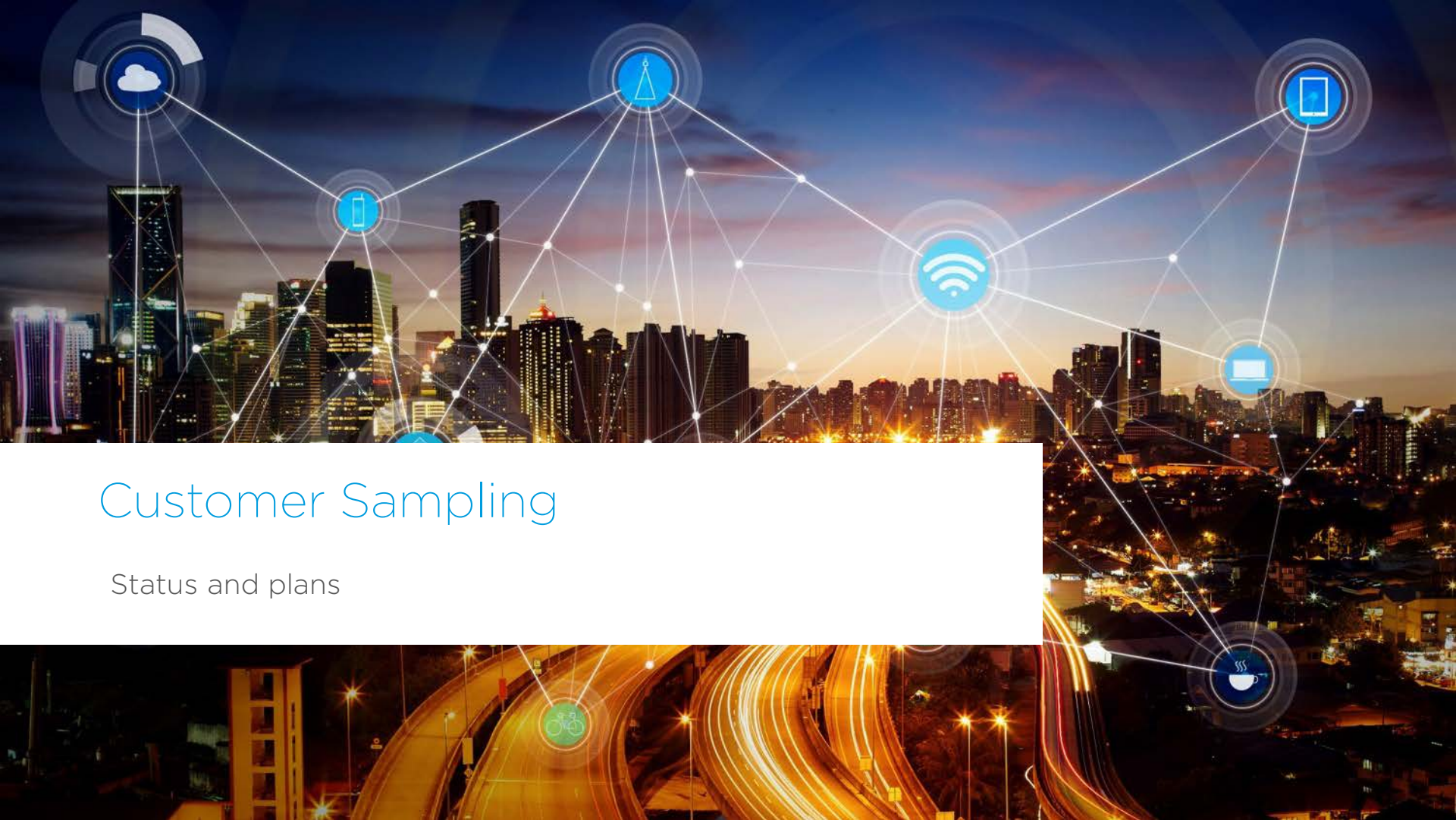
{ DevZone

Nordic self-service
software on Nordic
web and GitHub

Production

- Qorvo and Nordic already manufacture high-volume, quality products in billions
- A world-wide distribution network for fulfilment
- Quality systems in place to quickly resolve challenges





Customer Sampling

Status and plans

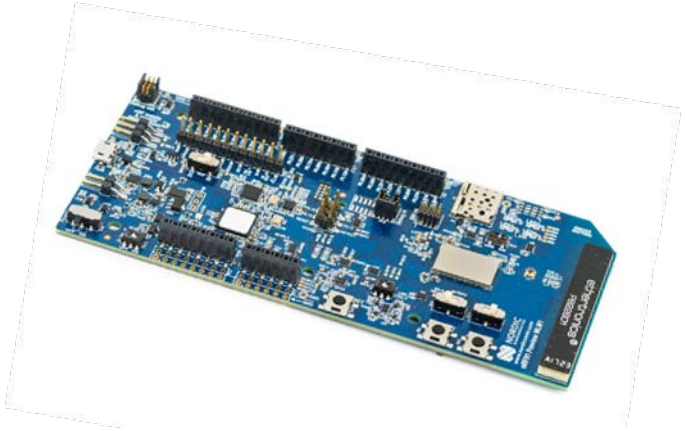
First NB-IoT customers sampled

Working on EU Networks

Addressing primarily static installations

Combines with LTE-M for efficient Firmware Over The Air (FOTA)

nRF91 lead customer sampling program



Diversified set of customers

Mix of BIG and FAST

Target to sample more than 100 by end of Q3

Sampled total of 75 customers

Diversified set of customers

Demand for first production quantities end-2018

First design win secured

European customers in asset tracking - FAST

Switched from a competing solution

Start of general availability Q4 2018

Priority is to secure design wins with lead customers

Secure volume ramp

Cellular IoT Analyst Briefing

Oulu, August 23, 2018

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