



Low Power Cellular IoT

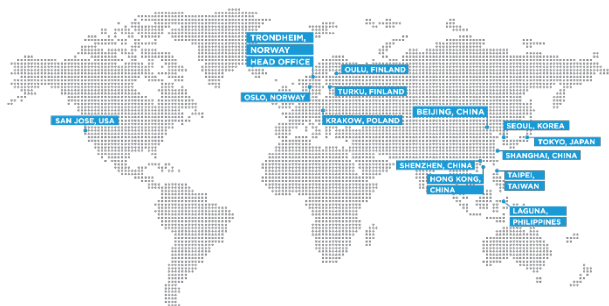
Technology and Applications

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IoT*

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About Nordic Semiconductor



Key Facts:

Founded in 1983, HQ in Norway

> 570 employees

R&D in Norway, Finland and

Poland

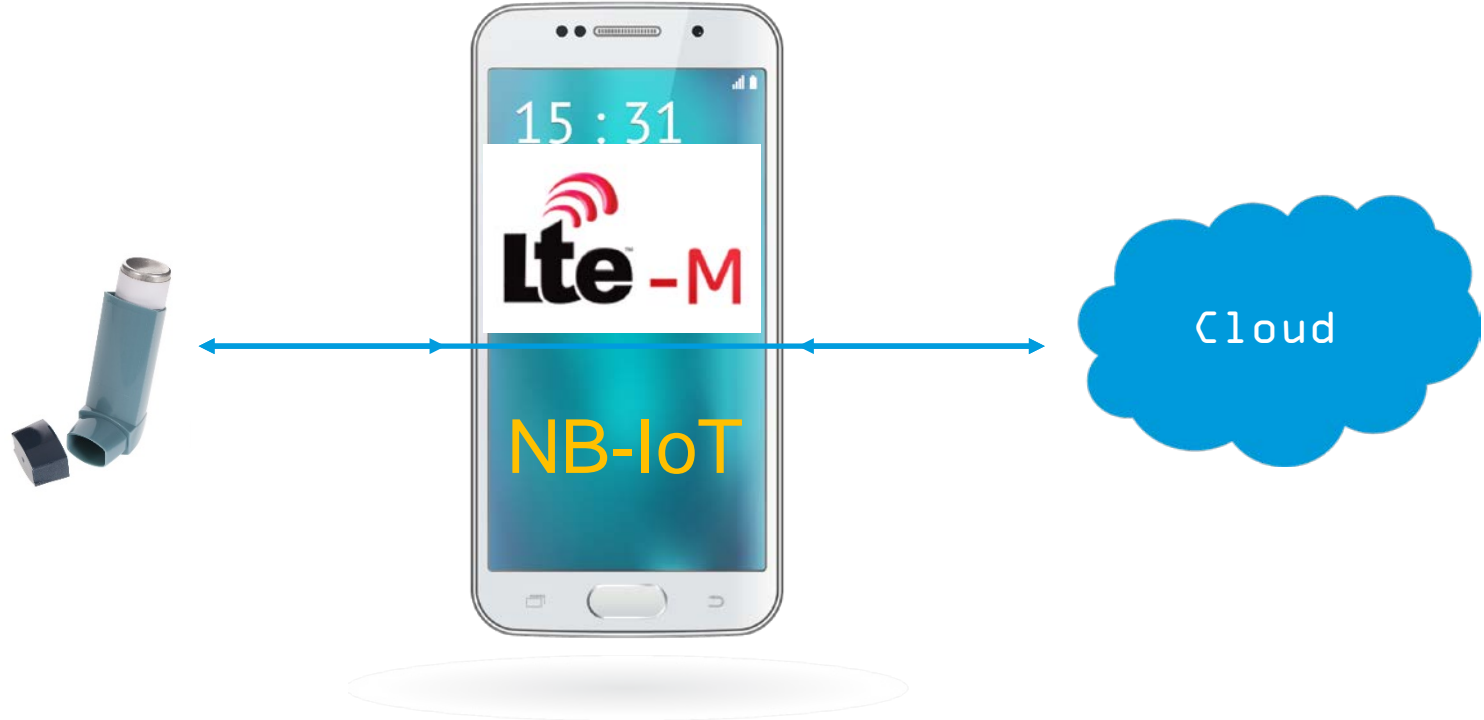
Publicly Listed (NYSE: NORD)

Market Cap 6000MUSD (Dec 2015)

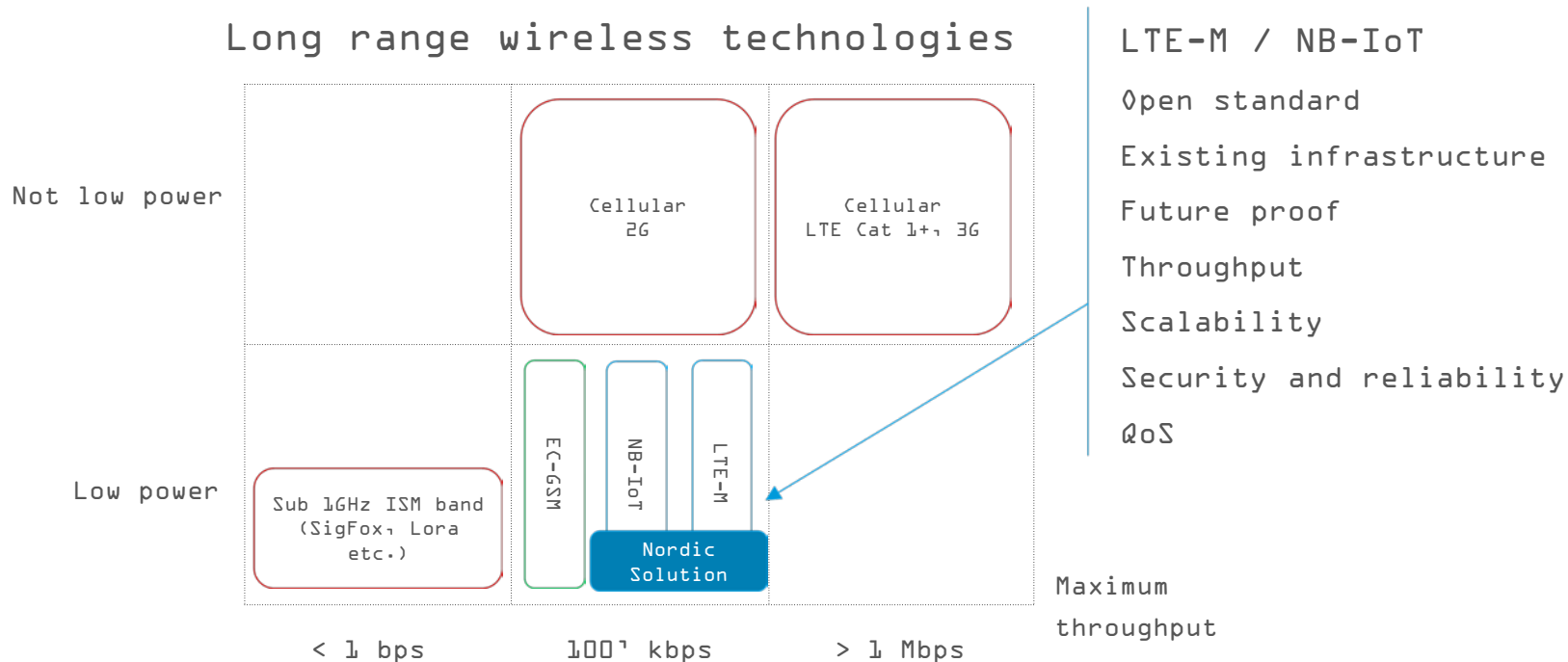
Key partners: TSMC, AMKOR, ASE

- Fabless Semiconductor Company
- Short-range Ultra low power wireless SoCs
- Bluetooth Low Energy® / 802.15.4 / ANT / 2.4GHz RF
- Market Leader in Bluetooth LE
 - 40% market share
 - Hundreds of millions of units shipped per year
 - 2000 customers in volume production (>10k units pr. year)
 - 40,000 development kits shipped pr. year
- Added experienced LTE design team in Finland

LPWAN - Removing the phone from LP M2M



LPWAN Technology landscape and strategy

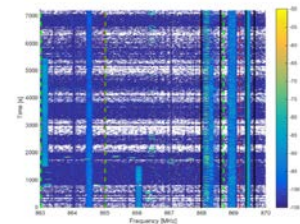


New low power LTE technologies

	LTE-M	NB-IoT
Also known as	"eMTC", "LTE Cat-M1"	"LTE Cat-NB1"
Max throughput	~ 375kbps	~ 30/60kbps
Max Coupling loss	155 dB	164 dB
Bandwidth	1.08 MHz	180 kHz
Range	Up to 4X	Up to 7X
Mobility	Yes	Limited
Deployment density	Up to 200,000 per cell	
Module size	Suitable for wearables	
Power consumption	Up to 10 year of battery lifetime	

LTE-M/NB-IoT vs. Competing LPWAN

cIoT in Licensed band gives
predictable QoS - no interference



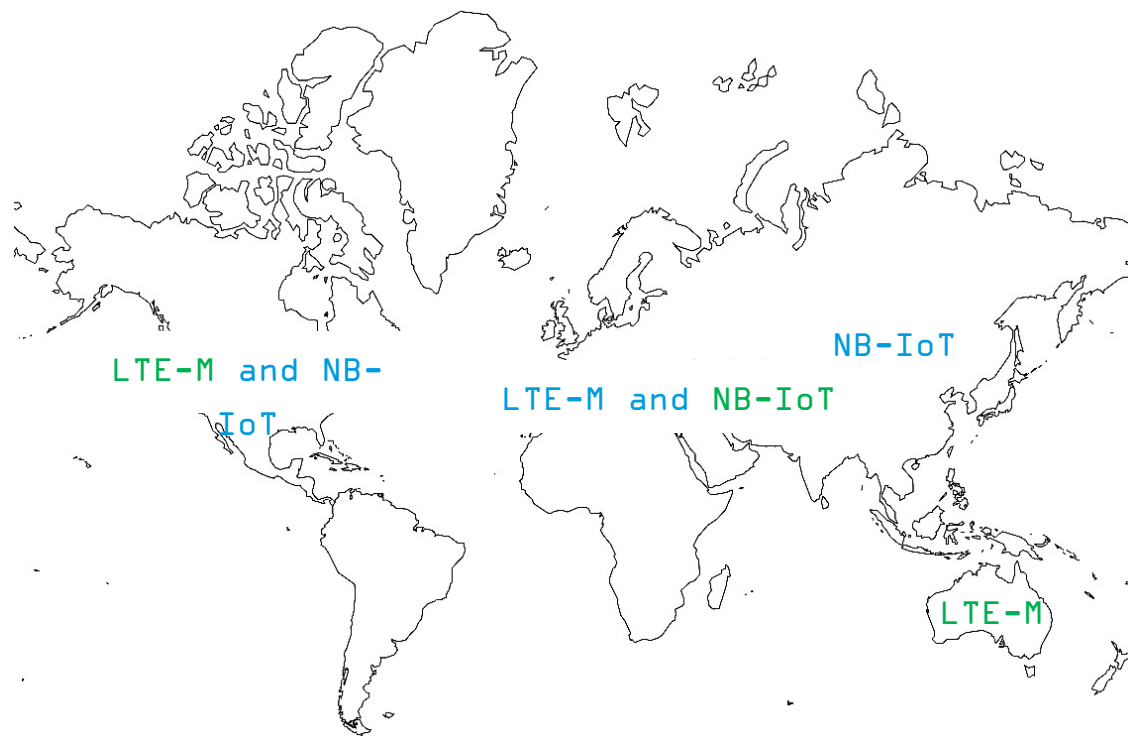
Security is built into LTE



No very limiting regulatory
restrictions on output power or duty
cycle



Deployment of LTE-M and NB-IoT networks



11 live commercial network deployments in Europe
7
Asia, US, China and Australia (GSMA)

Nationwide coverage in the US, Ireland, the Netherlands and Australia.

Frequency Deployment of LTE-M and NB-IoT

Table 5-5-1 E-UTRA operating bands

E-UTRA Operating band	Uplink (UL) operating band RB center E-UTRA		Downlink (DL) operating band RB center E-UTRA		Duplex Mode
	F _{up} - F _{up} max	F _{up} min - F _{up} max	F _{down} - F _{down} max	F _{down} min - F _{down} max	
1	1920 MHz	1920 MHz	2110 MHz	2110 MHz	FDD
2	1885 MHz	1910 MHz	1930 MHz	1930 MHz	FDD
3	1710 MHz	1710 MHz	1785 MHz	1785 MHz	TDD
4	1710 MHz	1785 MHz	2110 MHz	2110 MHz	FDD
5	825 MHz	825 MHz	860 MHz	860 MHz	FDD
6	825 MHz	860 MHz	1930 MHz	1930 MHz	FDD
7	2020 MHz	2020 MHz	2025 MHz	2025 MHz	FDD
8	880 MHz	880 MHz	915 MHz	915 MHz	FDD
9	1740 MHz	1740 MHz	1845 MHz	1845 MHz	FDD
10	1710 MHz	1710 MHz	2110 MHz	2110 MHz	FDD
11	1420 MHz	1420 MHz	1485 MHz	1485 MHz	FDD
12	880 MHz	880 MHz	915 MHz	915 MHz	TDD
13	770 MHz	770 MHz	740 MHz	740 MHz	FDD
14	740 MHz	740 MHz	770 MHz	770 MHz	FDD
15	Reserve	Reserve	Reserve	Reserve	FDD
16	Reserve	Reserve	Reserve	Reserve	FDD
17	100 MHz	100 MHz	1145 MHz	1145 MHz	FDD
18	810 MHz	810 MHz	860 MHz	860 MHz	FDD
19	810 MHz	860 MHz	810 MHz	810 MHz	FDD
20	830 MHz	830 MHz	790 MHz	790 MHz	FDD
21	1440 MHz	1440 MHz	1485 MHz	1485 MHz	FDD
22	2010 MHz	2010 MHz	2010 MHz	2010 MHz	FDD
23	2010 MHz	2010 MHz	2110 MHz	2110 MHz	FDD
24	1420 MHz	1420 MHz	1485 MHz	1485 MHz	FDD
25	1485 MHz	1485 MHz	1420 MHz	1420 MHz	FDD
26	510 MHz	510 MHz	590 MHz	590 MHz	FDD
27	800 MHz	800 MHz	850 MHz	850 MHz	FDD
28	800 MHz	850 MHz	750 MHz	750 MHz	FDD
29	300 MHz	300 MHz	310 MHz	310 MHz	TDD
30	2025 MHz	2025 MHz	2025 MHz	2025 MHz	FDD
31	480 MHz	480 MHz	480 MHz	480 MHz	FDD
32	1920 MHz	1920 MHz	1920 MHz	1920 MHz	FDD
33	1920 MHz	1920 MHz	1920 MHz	1920 MHz	FDD
34	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
35	1885 MHz	1885 MHz	1885 MHz	1885 MHz	TDD
36	1920 MHz	1920 MHz	1920 MHz	1920 MHz	TDD
37	1920 MHz	1920 MHz	1920 MHz	1920 MHz	TDD
38	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
39	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
40	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
41	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
42	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
43	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD
44	2010 MHz	2010 MHz	2010 MHz	2010 MHz	TDD

NOTE 1: Band 6 is not applicable.
NOTE 2: Resources in E-UTRA are used when carrier aggregation is configured. The downlink operating band is paired with the uplink operating band (antenna) of the carrier aggregation configuration that is supporting the configured PDSCH.

44 LTE bands

- From 400 MHz - 3.8 GHz (for now....)
- Some use FDD - Frequency Division Duplex
 - Different frequencies for Upload and Download from base station
- Some use TDD - Time Division Duplex
 - Same frequency UL and DL
- Different bands are licensed by different Carriers around the world...

How is it solved?

- Selections must be made
- Cell phones - many bands, but not all, iPhone 26 bands...
- Typical IoT LTE modules 2 - 6 bands = geographic or carrier specific

Frequency deployment

LTE-M: LTE In-band

NB-IoT: LTE In-band, guard band and GSM re-purposing

Low bands are ideal for deep indoor penetration and rural coverage

Cellular IoT Applications

Asset tracking



Location
Condition
Sub-units

Healthcare



Home Healthcare
Patient is not

Wearables



Un-teather from
the phone

Metering

Garbage Bins
Street lights
Sharebikes
Smart Parking

Leverage existing
infrastructure
Great coverage
and scalability

