NOKIA Bell Labs

AALBORG UNIVERSITY
DENMARK

How to choose the right LPWA IoT technology

Mads Lauridsen
Standardization Research, Nokia Bell Labs, Aalborg
Wireless Communication Networks, Aalborg University
mads.lauridsen@nokia-bell-labs.com

IDA TELE 2018
October 24, 2018
Copenhagen

© 2018 Nokia

Sorry…

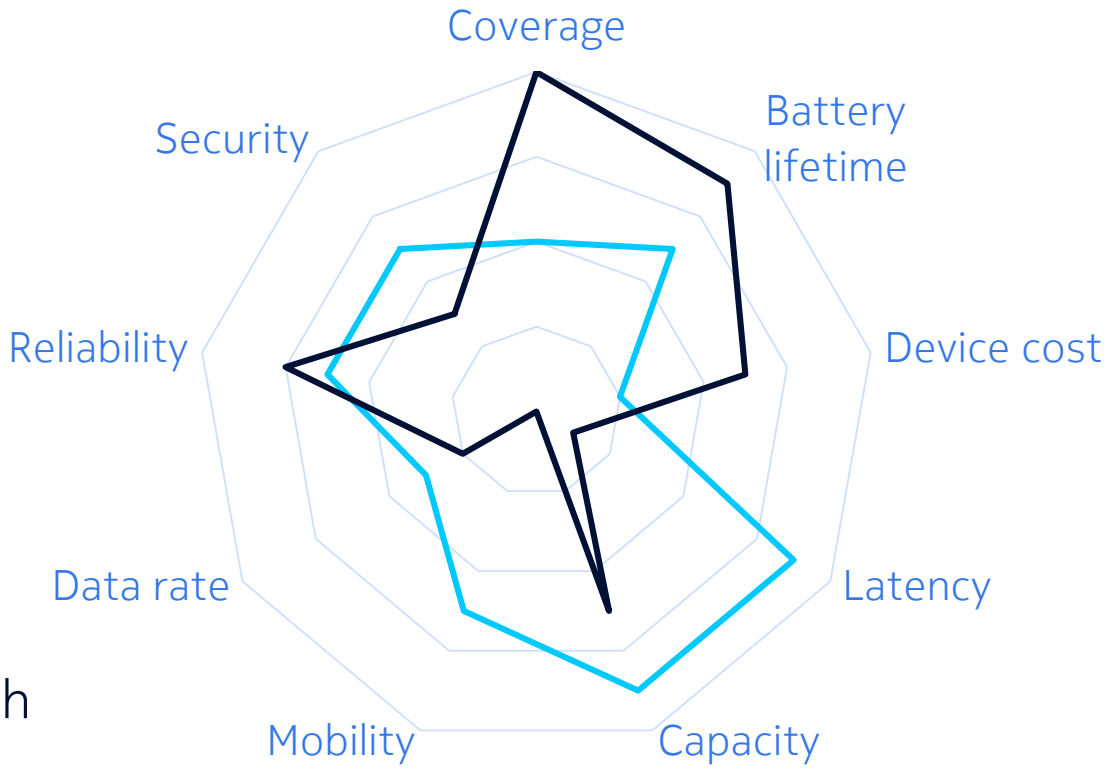
No *one size fits all* technology,
but I will tell you what to think about,
to make the *right choice*

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

Low-Power Wide-Area Essentials

- Long range coverage
- Long battery lifetime
- Low bandwidth & low data rate
- Low modem cost



Shannon's theorem:

capacity = bandwith $\log_2$ (1+Signal / Noise)

- Signal↑ : Repetition & coding (→link adaptation)
- Noise↓ : low thermal noise through small bandwidth
- <1 GHz deployment

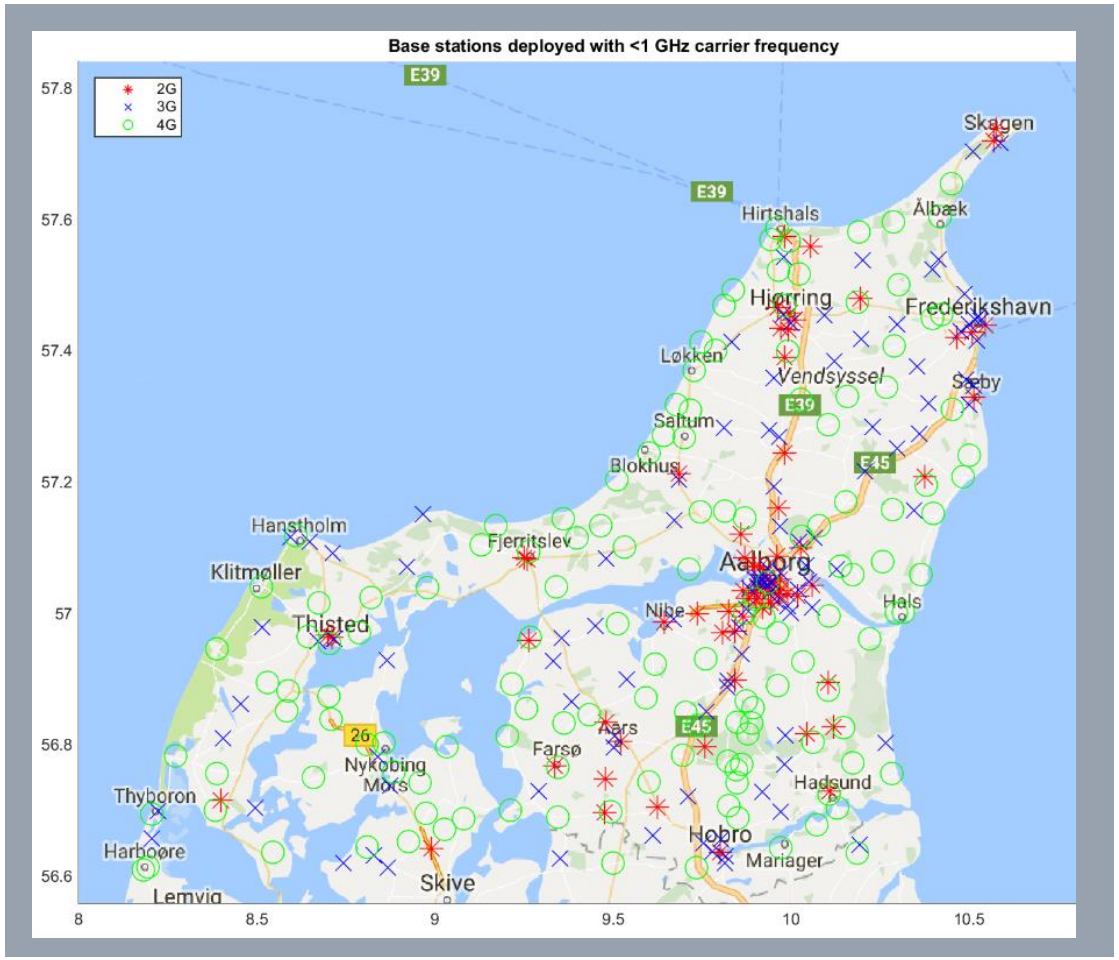
Low-power device and wide-area coverage are contradicting!

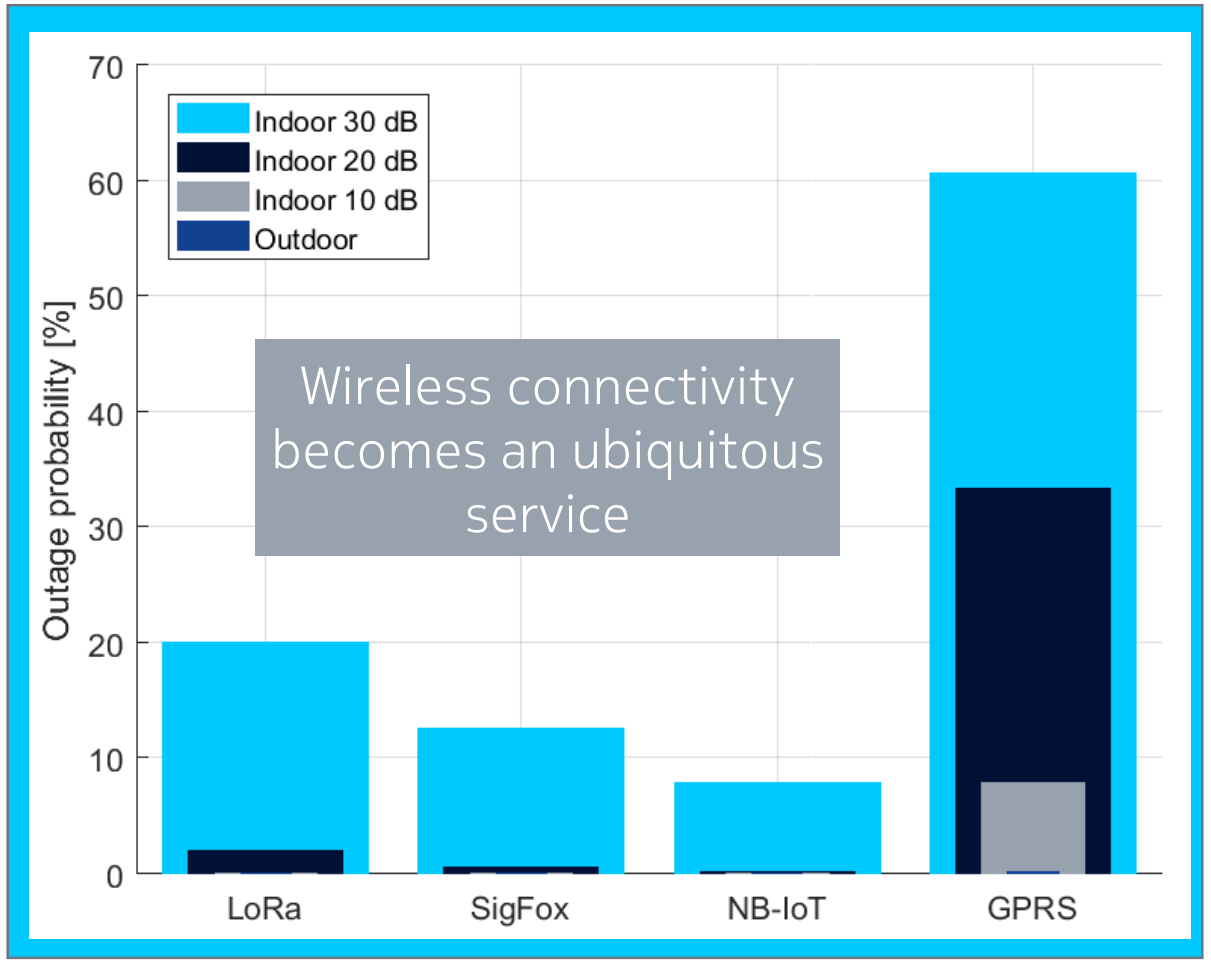
© 2018 Nokia

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

IoT Coverage Probability Study - Nordjylland





© 2018 Nokia

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

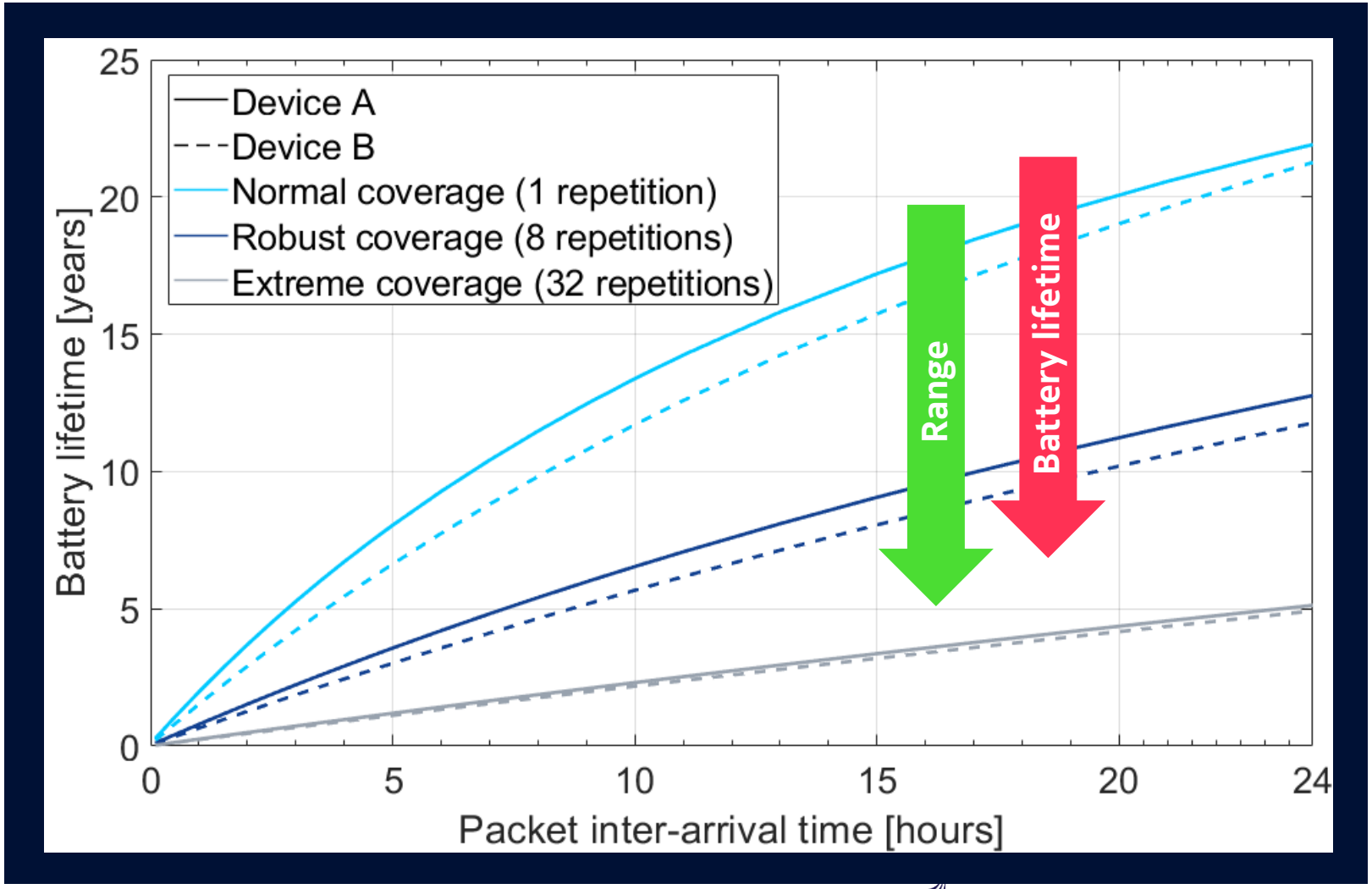
Estimated NB-IoT battery lifetime using real measurements

Extended coverage entails
- higher transmit power
- longer transmissions

(except Sigfox)

→ Shorter battery lifetime
→ Lower network capacity

Which Key Performance Indicators to use, when selecting the LPWA IoT technology?



© 2018 Nokia

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

Low-Power Wide-Area Technologies in Europe

Technology	LoRa™		sigfox		NB-IoT		LTE-M	
	UL	DL	UL	DL	UL	DL	UL	DL
Frequency Spectrum [MHz]	863-870 (3 mandatory)		868.0-868.6	869.4-869.65	832-862	791-821	832-862	791-821
Spectrum regulation	ISM, unlicensed		ISM, unlicensed		Licensed		Licensed	
Maximum Coupling Loss [dB]	154	152	158	161	167	169	161	170
Estimated urban range [km]	5.6		7.3		13.1		8.9	
Max payload [bytes]	222 (51 @ MCL)	222 (51 @ MCL)	12	8	128	85	85	85
Remote software update	Limited by duty cycle, multicast available		Limited by duty cycle and payload size		Possible using multicast		Possible using multicast	
Global roaming	Possible		Supported		Possible through (e)SIM or virtual operator			
Device mobility	Device not connected to 1 BS		Device not connected to 1 BS		Cell reselection		Handover	
Device localization	RSSI + time difference of arrival		RSSI-based + beacons		Time difference of arrival (release 15)			
Mode of operation	Self-owned or hybrid		Subscription incl. cloud service		Mobile Network Operator			
Device cost [USD, 2018]	2-5		2		7-9		8-10	

© 2018 Nokia

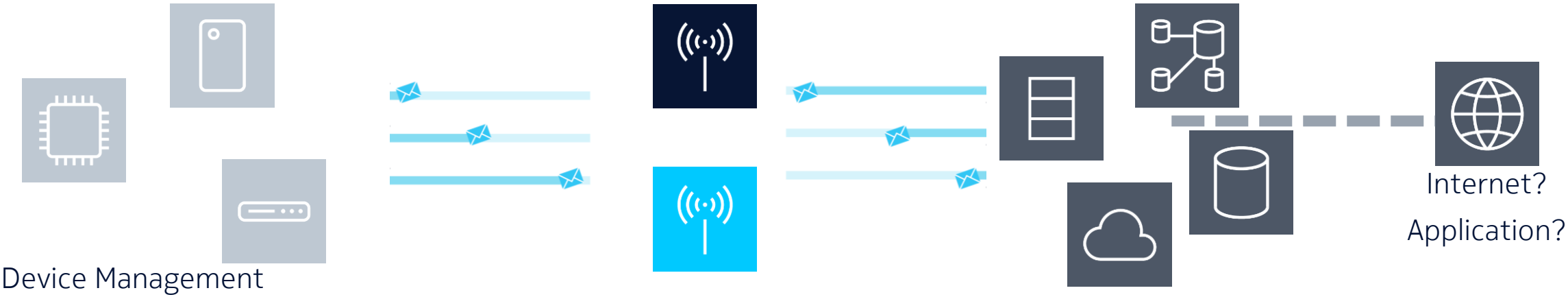
AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

More KPIs to consider

End-to-end service

Security (authentication + encryption) — Backhaul — Backend (server/NW core location)



Device Management

- Change cloud server
- Firmware update
- Sensors & transmission configuration
- Downlink for actuators?

Battery lifetime, f(app, NW)

Reliability / availability

Packets — Network

Network management

- Cyber security
- Planning & maintenance
- Public or private?

Software/platform/infrastructure as a service

Capital expense vs operational expense

© 2018 Nokia

AALBORG UNIVERSITY DENMARK

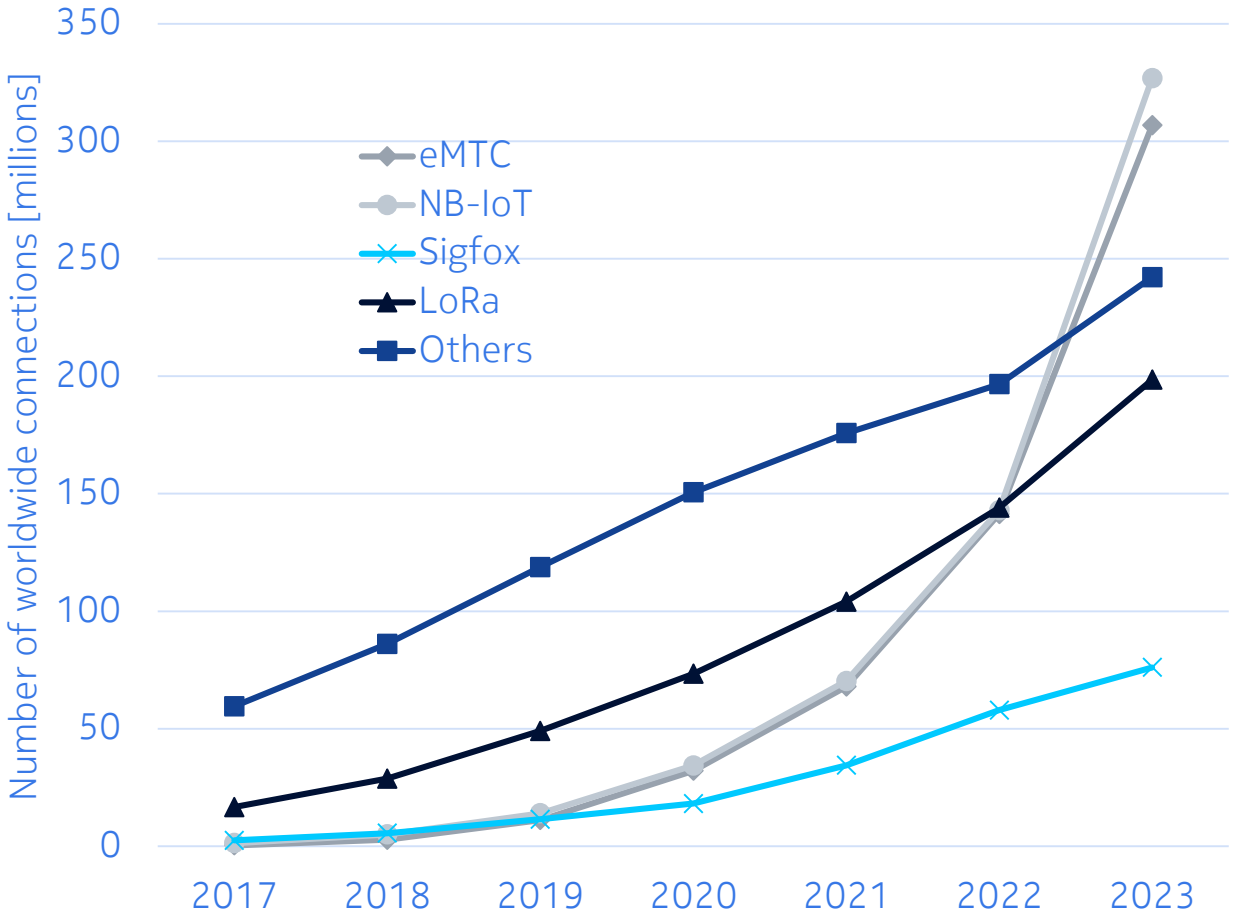
NOKIA Bell Labs

No chance without network(s) and devices
World market trends

Technology	Total	Notes
LoRa	88	LoRa Alliance: 96 operators (51 countries)
Sigfox	51	Sigfox.com: 55 countries
eMTC	25	GSMA: 66 commercial by Sep.18, ~75 % is NB-IoT, 35 countries
NB-IoT	81	
Others	106	RPMA, Telensa UNB, Cat-1, EC-GSM-IoT

ABI Research, Base station infrastructure, July 2018

*Total includes both private & public, nationwide and local, trials & announced networks deployments



ABI Research, Low-Power Wide Area Network Market Data, May 2018

*Others: Ingenu, Weightless SIG, Sensus, Aclara, and LoJack

© 2018 Nokia

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

Concluding remarks

- The journey towards the digitized society has started
  - It requires 100 % coverage, but also 100 % reliability
  - Without 24/7 connectivity, Denmark will come to a stop

- Sigfox is the leanest technology, while eMTC is the most flexible
  - LoRa & NB-IoT are versatile solutions in between

- Know your current & future application needs
  - Don’t underestimate need for device management

AALBORG UNIVERSITY
DENMARK

NOKIA Bell Labs

AALBORG UNIVERSITY
DENMARK