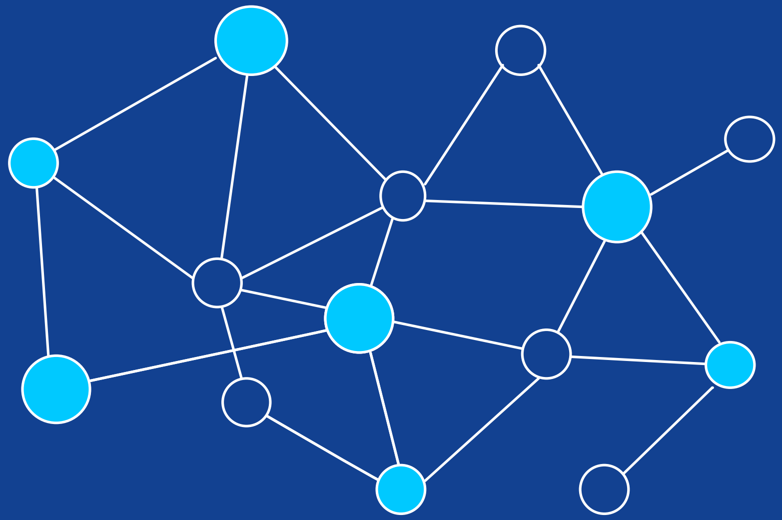
NB-IoT deployment

Alessandro Bovone
UK&I Chief Solution Architect
September 26th, 2017



Content

1. LPWA Overview (NB-IoT/LTE-M)

2. NB-IOT modes of operations

3. Global NB-IoT/LTE-M Trend

4. IoT EtoE Nokia solution

LPWA Overview
(NB-IoT/LTE-M)

IoT Low Power Wide Area (LPWA) technologies

	LoRa	GSM (3GPP	EC-GSM-IoT (3GPP Rel.	LTE (3GPP Rel.	LTE-M/eMTC (3GPP Rel.	NB-IoT (3GPP Rel.13)
One global specification	Regional flavors*	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**
Public specification	No	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**	**Yes, 3GPP**
LTE user equipment category				Cat.1	Cat.M1	Cat.NB1
Range Maximum Coupling Loss	Various claims 155/154dB/tbd*	<35km 144 dB	<35km **164 dB**	**<100km** 144dB	**<100km** 156 dB	<35km **164 dB**
Spectrum	Unlicensed 867-869MHz, 902-928MHz, … (Europe, North America, other tbd.)*	**Licensed** GSM bands	**Licensed** GSM bands	**Licensed** LTE in-band	**Licensed** LTE in-band	**Licensed** LTE in-band LTE guardband standalone
Bandwidth	125,250/500kHz (Europe/North America/other tbd.)*	200kHz	200kHz	LTE band carrier bandwidth (1.4 – 20MHz)	1.08MHz (1.4MHz carrier bandwidth)	180kHz (200kHz carrier bandwidth)
Max. data rate	<50/<22kbps/tbd. (Europe/North America/other tbd.)*	<500kbps	<140kbps	**<10Mbps**	**<1Mbps**	<250kbps

*: source: LoRa Alliance Whitepaper published 11/2015 (and not updated as of 6/2016)

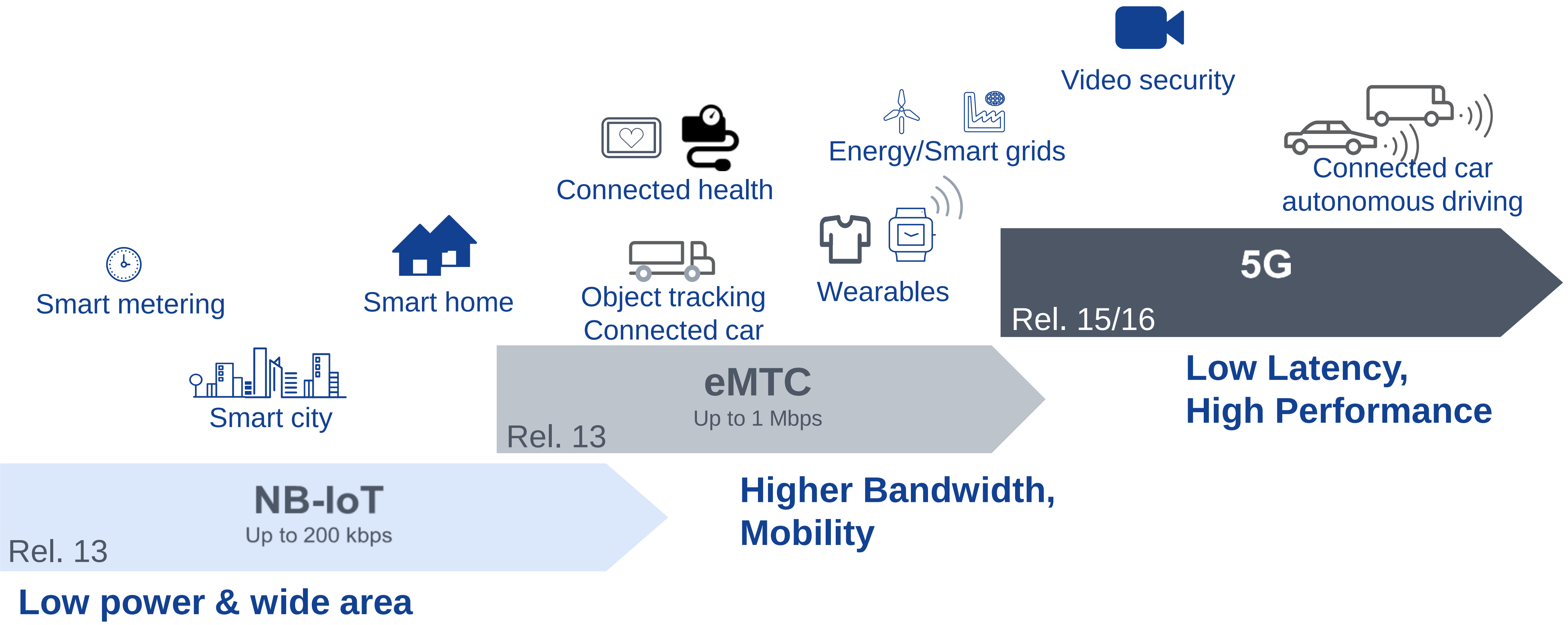
Note: eMTC (enhanced Machine Type Communication) is the official 3GPP term (a.k.a LTE-M) for enhancements in Rel-13

LTE Radio technologies

		Release 8		Release 13		
Modem/device chip category		**Category 4**	**Category 1**	**Category M1 (LTE-M/eMTC)**		**Category NB1 (NB-IoT)**
Peak data rate instantaneous	Downlink	150 Mbps	10 Mbps	1 Mbps		170 kbps
	Uplink	50 Mbps	5 Mbps	1 Mbps		250 kbps
Peak data rate sustained	Downlink	150 Mbps	10 Mbps	890 kbps	300 kbps	26 kbps
	Uplink	50 Mbps	5 Mbps	1 Mbps	375 kbps	62kbps
Duplex mode		Full duplex	Full duplex	Full duplex	Half duplex	Half duplex
Number of antennas		2	2	1		1
UE receive bandwidth		1.4/3/5/10/ 15/20 MHz	1.4/3/5/10/ 15/20 MHz	1.08 MHz		180 kHz
UE transmit power		23 dBm	23 dBm	20/23 dBm		20/23 dBm
Multiplexed within LTE		Yes	Yes	Yes		Yes/No
Modem complexity		**100%**	**80%**	**20%**		**15%**

MTC Coverage for IoT use cases

Both eMTC and NB-IoT are required to be deployed to cover various use case for IoT



Optimizing connectivity for the IoT

Use case requirements and wide area networks

Today	Importance of availability and reliability of connectivity		Importance of device cost, size and battery life	Tomorrow
LTE (+MEC)	High	**Critical** Eg: smart devices in public safety	Low	5G
LTE-M		**Industrial** Eg: telematics		5G and MulteFire
NB-IoT EC-GSM LoRa	Low	**Massive** Eg: sensors in pollution monitors	High	5G and MulteFire

Key building blocks to enable 3GPP based IoT/M2M (NB-IoT/LTE-M/EC-GSM)

Lower cost device	Modem cost <5 USD
Lower power consumption	Battery life >10 years with 2 AA batteries
Enhanced coverage	Extended path loss +15 or +20 dB
High capacity core network	Signalling and network entity optimization
Sharing carrier capacity	Single LTE network

Frequency bands

- Release 13 specification supports frequency bands 1, 2, 3, 5, 8, 12, 13, 17, 18, 19, 20, 26, 28, 66
- Release 14 will support these additional bands: Band 11 (1.5 GHz), Band 25 (1.9 MHz), Band 31 (450 MHz) and Band 70 (Dish 1.7/1.9 GHz)
- Low frequency bands give better coverage
- Device support also needed

Band	Frequency (MHz)	NB-IoT?
1	2100	Rel 13
2	1900	Rel 13
3	1800	Rel 13
4	1700	
5	850	Rel 13
6	850	
7	2600	
8	900	Rel 13
9	1800	
10	1700	
11	1500	Rel 14
12	700	Rel 13
13	700	Rel 13
14	700	
15	2600	
16	2600	
17	700	Rel 13

Band	Frequency (MHz)	NB-IoT?
18	850	Rel 13
19	850	Rel 13
20	800	Rel 13
21	1500	
22	3500	
23	2000	
24	1600	
25	1900	Rel 14
26	850	Rel 13
27	850	
28	700	Rel 13
29	700	
30	2300	
31	450	Rel 14
32	1500	
33	2100	
34	2100	

Band	Frequency (MHz)	NB-IoT?
35	1900	
36	1900	
37	1900	
38	2600	
39	1900	
40	2300	
41	2500	
42	3500	
43	3700	
44	700	
45	1500	
46	5200	
65	2100	
66	1700	Rel 13
67	700	
68	700	
69	2600	
70	1700	Rel 14

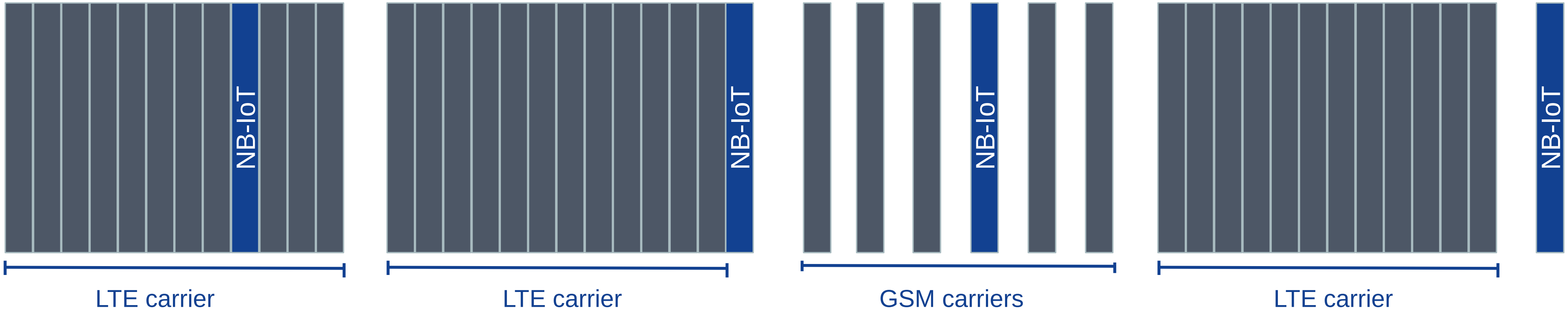
NOKIA

NB-IoT Release 14 enhancements

Position Tracking	Positioning support (E-CID, UTDOA or OTDOA)
Firmware and software updates, group message delivery	Multicast Support
Better service continuity	Enhanced connected mode mobility for service continuity
Competitive wearables support	Lower device Tx power (~14 dBm) for power and cost optimized wearables (at cost of coverage)
Capacity Enhancements	Optimized multicarrier NB-IoT operations

NbIoT Modes of operation

NB-IoT– Modes of Operation



in-band

utilize resource blocks within a normal LTE carrier

guard band

utilize the unused resource blocks within a LTE carrier's guard band

Standalone

utilize for example
-the spectrum currently being used by GERAN systems as a replacement of one or more GSM carriers.
- or LTE spectrum in position other than guard band

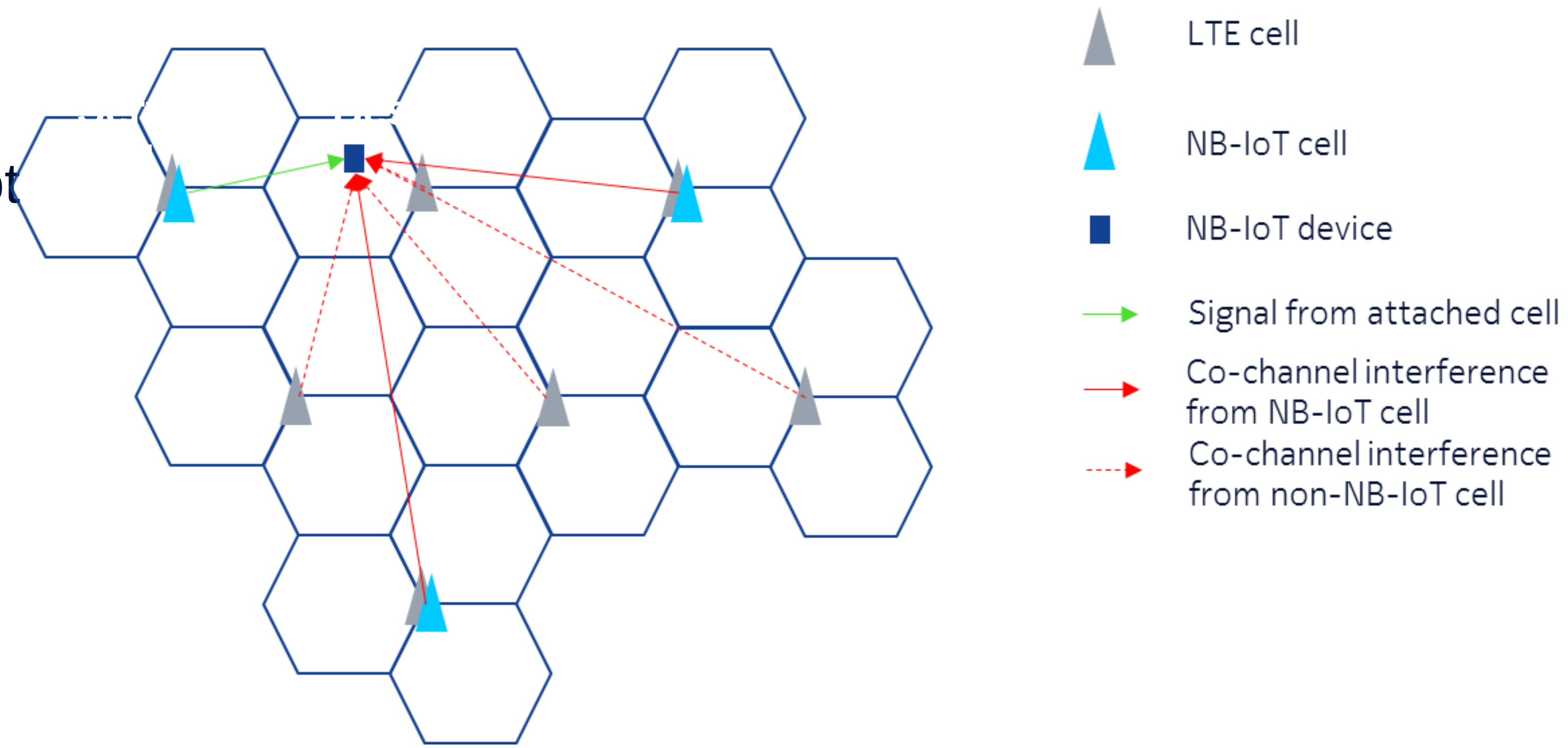
Deployment aspects

- In-band option enables cost competive deployments - support in existing LTE network
- Rel-13 NB-IoT only specified for FDD

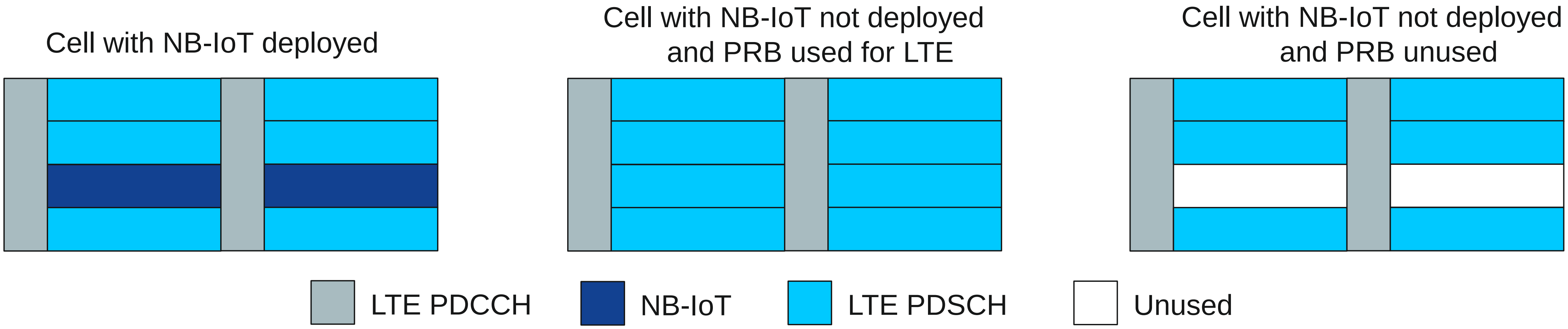
NOKIA

Partial Deployment of In-band NB-IoT in Network

- With partial deployment, NB-IoT devices cannot attach to the best cell if that cell does not support NB-IoT
  - High pathloss since they cannot attach to the best cell
  - High interference from non-NB-IoT cells, especially from best cell



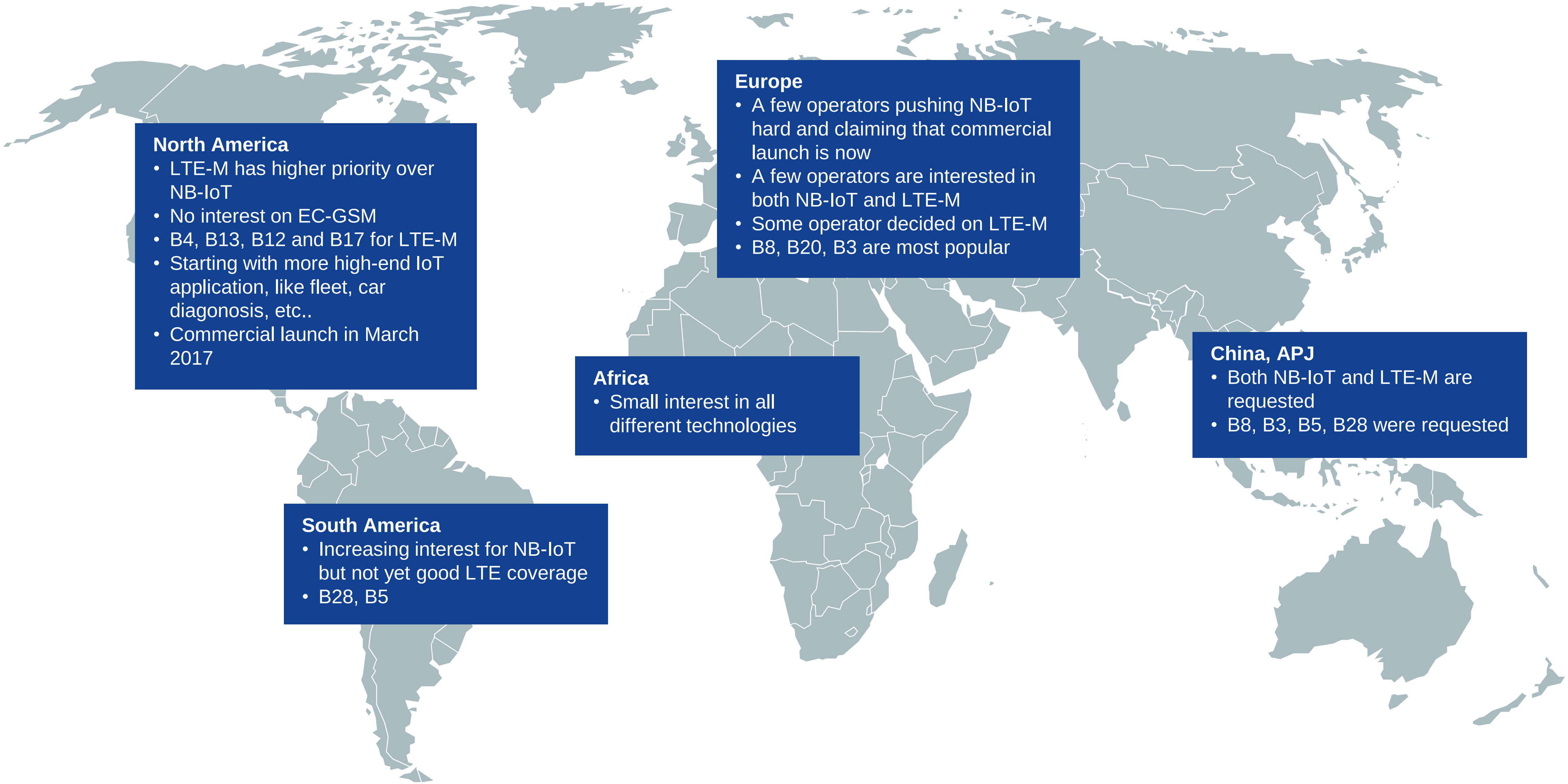
Partial Deployment of In-band NB-IoT in Network



- NB-IoT may be deployed in only a fraction of all LTE cells
- Other cells (non-NB-IoT cells) may either use the PRB used by NB-IoT for LTE or leave it unused
  - Affects interference experienced by NB-IoT devices

Global NbIoT/LTE-M Trend

NB-IoT/LTE-M Global Trend



North America
- LTE-M has higher priority over NB-IoT
- No interest on EC-GSM
- B4, B13, B12 and B17 for LTE-M
- Starting with more high-end IoT application, like fleet, car diagonosis, etc..
- Commercial launch in March 2017

Europe
- A few operators pushing NB-IoT hard and claiming that commercial launch is now
- A few operators are interested in both NB-IoT and LTE-M
- Some operator decided on LTE-M
- B8, B20, B3 are most popular

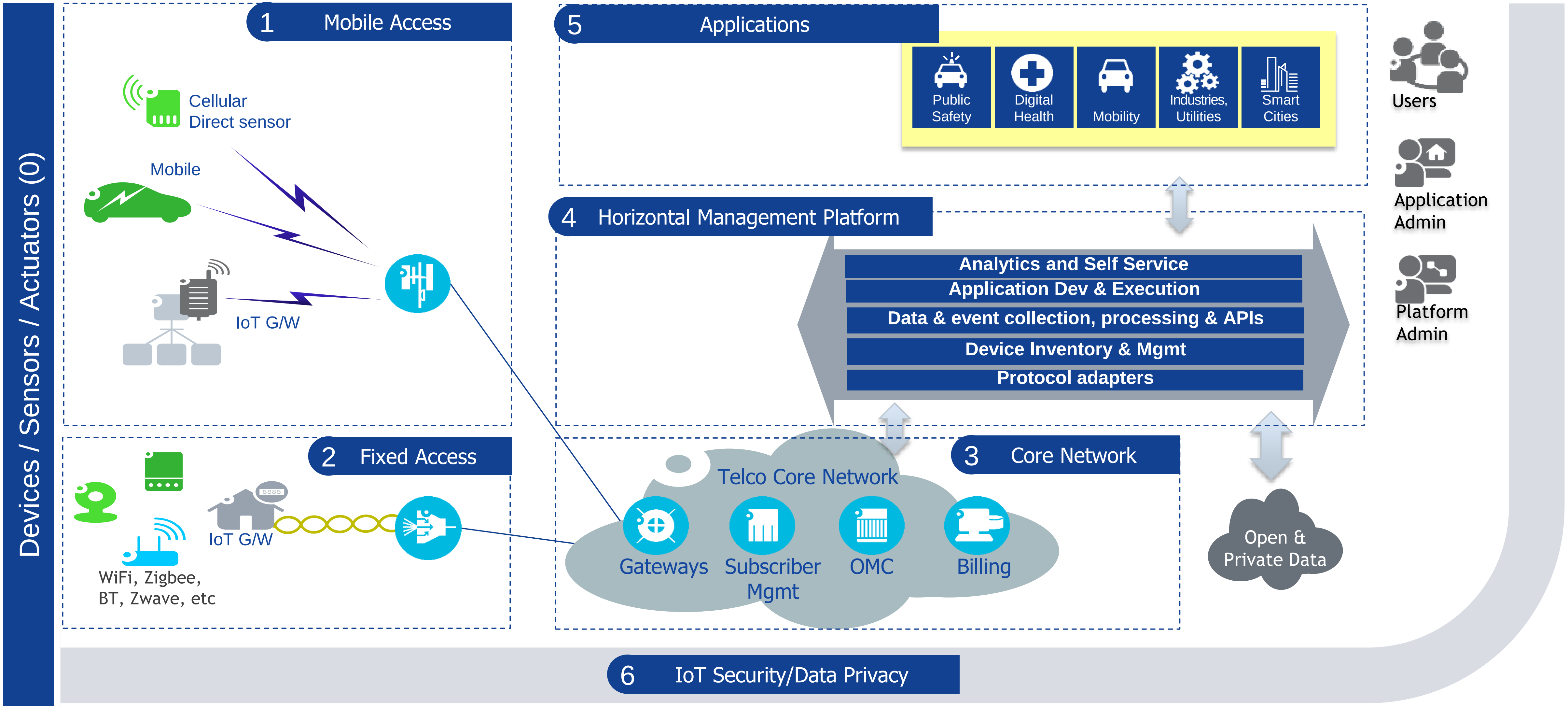
Africa
- Small interest in all different technologies

China, APJ
- Both NB-IoT and LTE-M are requested
- B8, B3, B5, B28 were requested

South America
- Increasing interest for NB-IoT but not yet good LTE coverage
- B28, B5

NB-IoT EtoE Nokia Solution

Nokia IoT – 7 touchpoints for a unified delivery architecture



NOKIA

LTE NB-IOT Network E2E architect

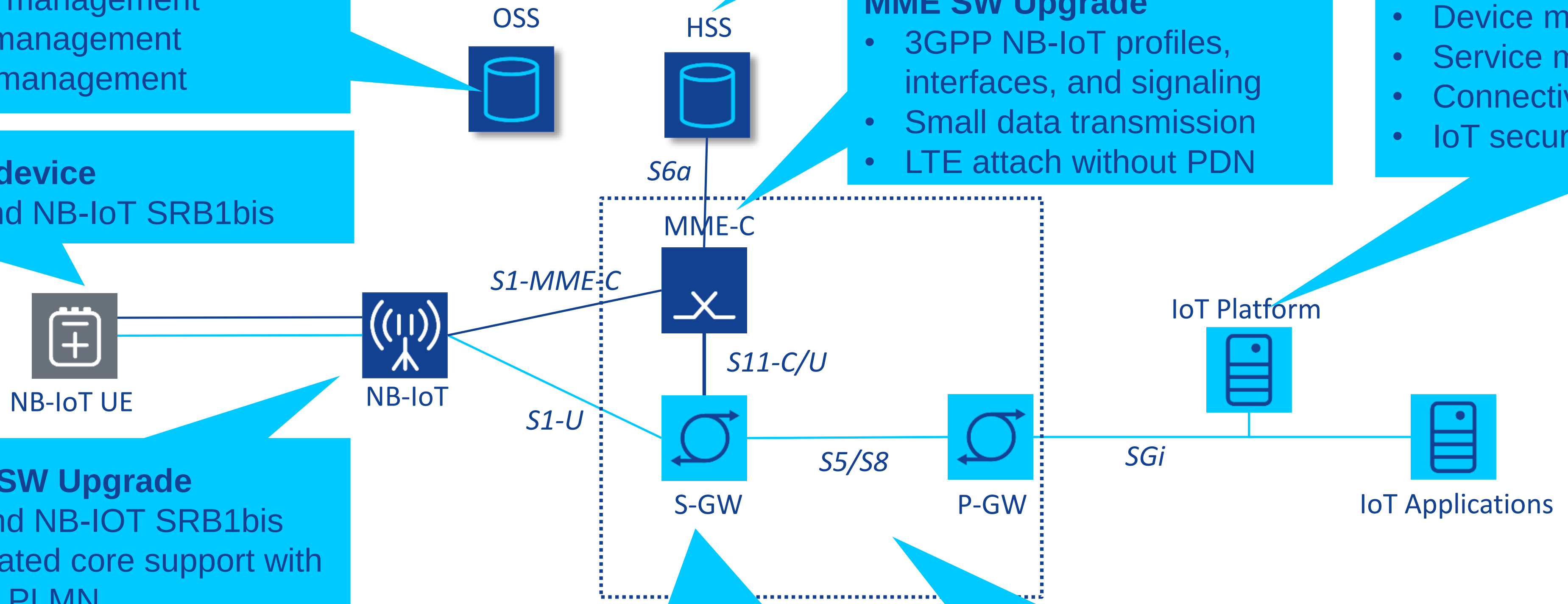
HSS SW Upgrade
- 3GPP NB-IOT profile

OSS SW Upgrade
- Radio management
- EPC management
- SDM management

NB-IOT device
- In-band NB-IoT SRB1bis

MME SW Upgrade
- 3GPP NB-IoT profiles, interfaces, and signaling
- Small data transmission
- LTE attach without PDN

“Optional” IoT platform (IMPACT)
- Application development and execution platform
- Device management
- Service management
- Connectivity management
- IoT security



NB-IOT SW Upgrade
- In-band NB-IOT SRB1bis
- Dedicated core support with single PLMN

SGW SW Upgrade
- 3GPP NB-IoT Interfaces

Common or dedicated vEPC
- Virtualized EPC and/or HSS
- C-SGN option

NOKIA