IoT Wireless Access Networks: Where to Go From Here?

Andrei Alexandru Enescu, Ph D

EOS Electronic Systems, CEO

20-Feb-2017

EOS ELECTRONIC SYSTEMS

Why This Presentation?

- IoT Market is **BIG**

- Monetization opportunities at various levels:
  - Sensors
  - IoT Hw boards
  - Gateways & Connectivity
  - Servers
  - Applications
  - Big Data Software
  - Visualisation
  - Security

BAIN & COMPANY

Cumulative $470B revenue by 2020

$60 tril. investment during the next 15 years

IHS

15.4 bil. devices (2015) -> 30.7 bil. devices (2020) -> 75.4 bil. Devices (2025)

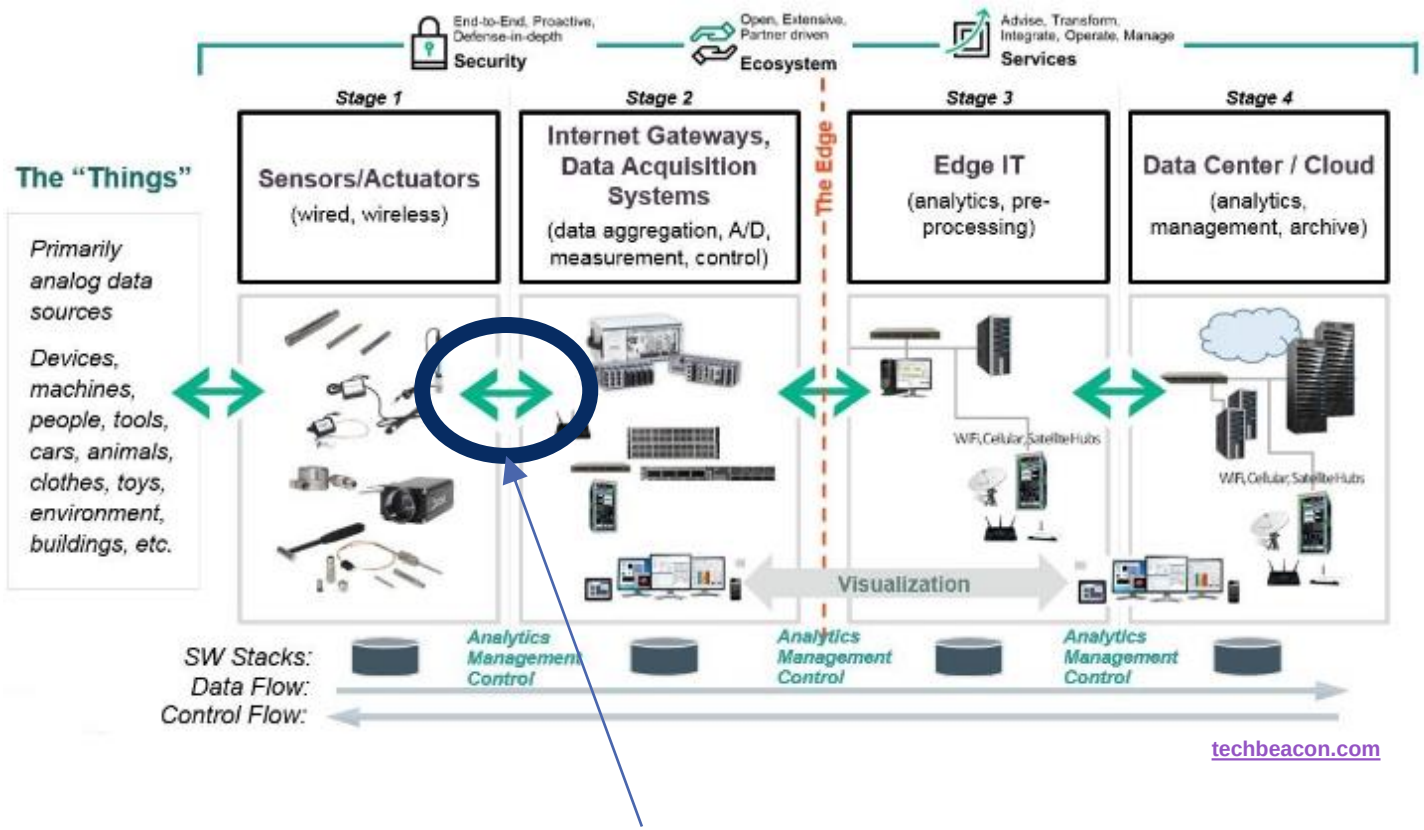
McKinsey&Company

$900M (2015) -> $3.7B (2020)
CAGR = 32.6%

EOS ELECTRONIC SYSTEMS

Why This Presentation? (2)

- IoT infrastructure grows fast but non-organically
  - Time to market without scalability and time for harmonization
- There are multiple options for each piece of the infrastructure
- Limited guaranteed interaction between the pieces



Focus of this presentation

ELECTRONIC SYSTEMS

Goal of the Presentation

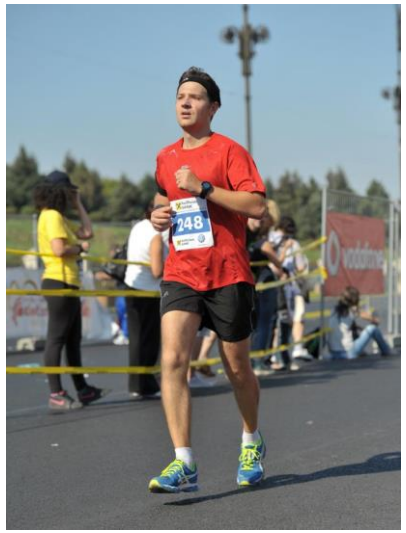
- Objectively present the options for the wireless connectivity of things.

- Focus only on Low Power Wide Area (LPWA) that can connect anything to anything
  - Exclude Bluetooth, Zigbee, WiFi

- Highlight which technology is suitable for different use cases

Who Am I?

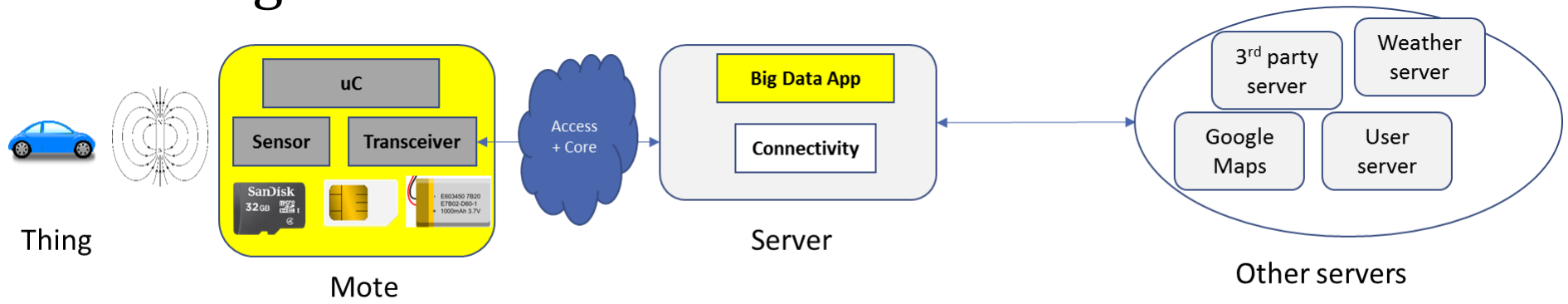
- B. Sc. And Ph D from University Politehnica of Bucharest
  - MIMO Communications & Algorithms
- Research Activity
  - DSP – Adaptive Filtering
  - Wireless Receivers – MIMO decoders
- Baseband Software
  - Technical Manager for Baseband eNodeB SoC Software
- IoT
  - CEO of an emerging IoT start-up



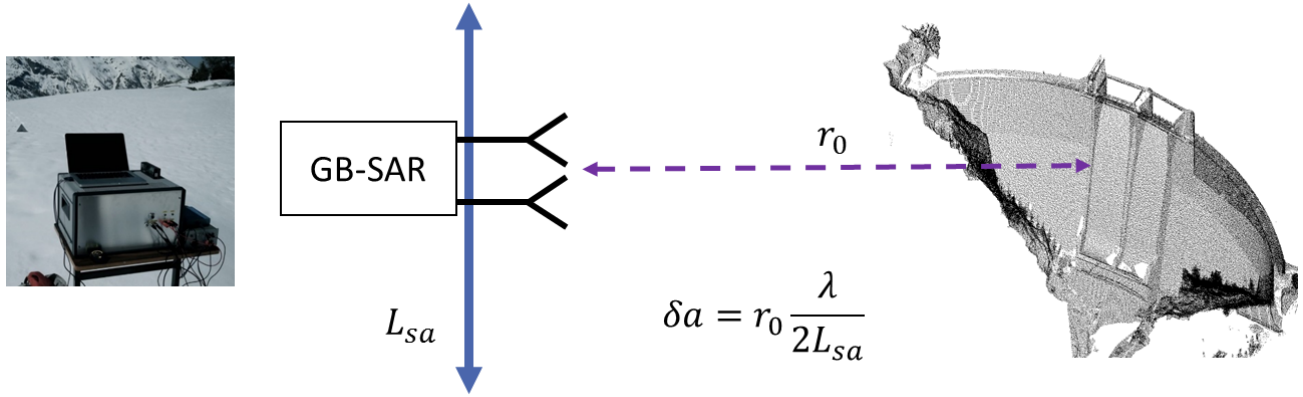
EOS ELECTRONIC SYSTEMS

The Company That I Represent

- Founded in 2016
- Traffic Management Solution



- Track 3D displacements of infrastructure



ELECTRONIC SYSTEMS

Agenda

- LPWA Technologies
- Criteria to analyze contenders
- Comparison analysis
- Conclusions

What is LPWA?

Long Battery Life

10 years

Low Cost

$ 5-10 / sensor

Bluetooth 4.0

SIGFOX
One network A billion dreams

DASH7 ALLIANCE

Z-Wave

LoRa™

INGENU

greenWAVE systems®

WEIGHTLESS™

NB-LTE
EC-GSM
LTE-M

nwave

Wide Area

2-5 km

Limited Capacity

20 – 100 kbps

EOS ELECTRONIC SYSTEMS

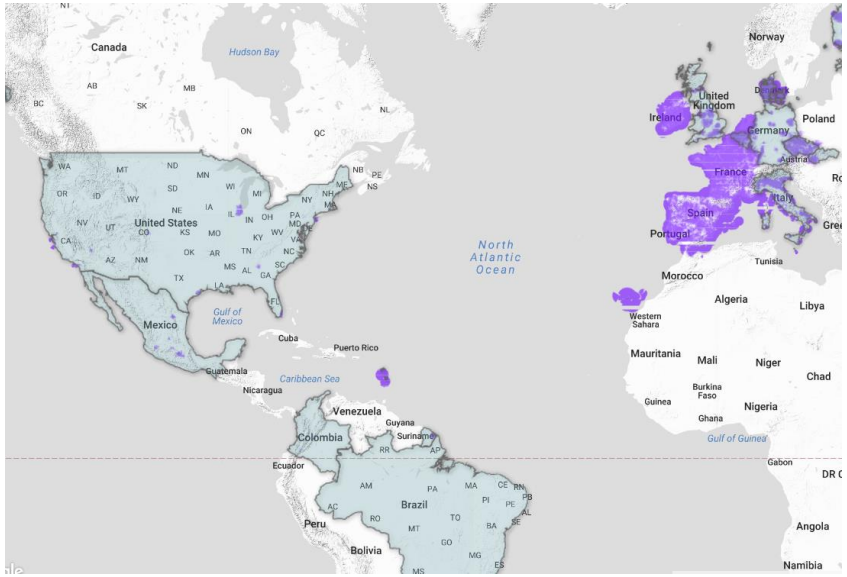
What is not LPWA (per se)?

	ZigBee Alliance	802.11af/ah	CAT-M1/0/1	Bluetooth
	5 – 10 years	< 1 year	1-5 years	5 – 10 years
	30 meters	< 1km	1-5km	< 100 meters
	$1-$3	?	> $10	$1
	250kbps	1Mbps	> 100kbps	< 100kbps

EOS ELECTRONIC SYSTEMS

Sigfox – Flying IoT at Supersonic Speeds

Aggressive roll-out



Raised $300M from 2010

US IPO in discussion

140 messages x 12 bytes per day over uplink

4 messages x 8 bytes per day over downlink (no ACK!)

UNB 10/50km 10-15 years $1

Downlink		Uplink
869.4MHz	BAND	868MHz
1.5kHz	BW	100Hz / 600Hz
GFSK	MOD	DBPSK
27dBm / 36dBm	PWR	14dBm
153dB	LINK	155dB
600bps	RATE	100/600bps

EOS ELECTRONIC SYSTEMS

LoRA – Together We Can Go Further

LoRa Alliance™
Wide Area Networks for IoT

Senet and Actility raised $51M

Founded in 2015 at MWC

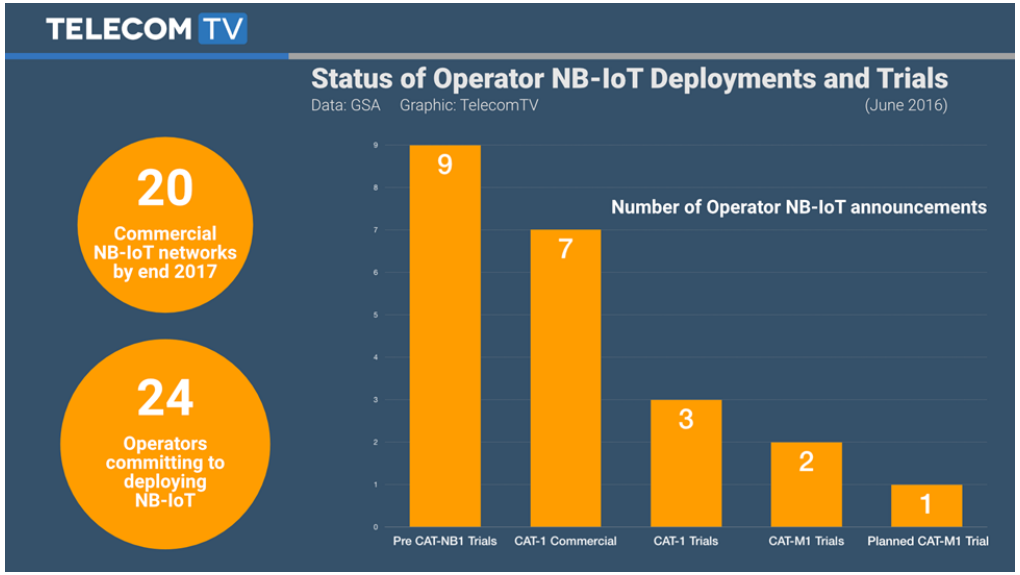
LoRa Alliance membership went up 3x

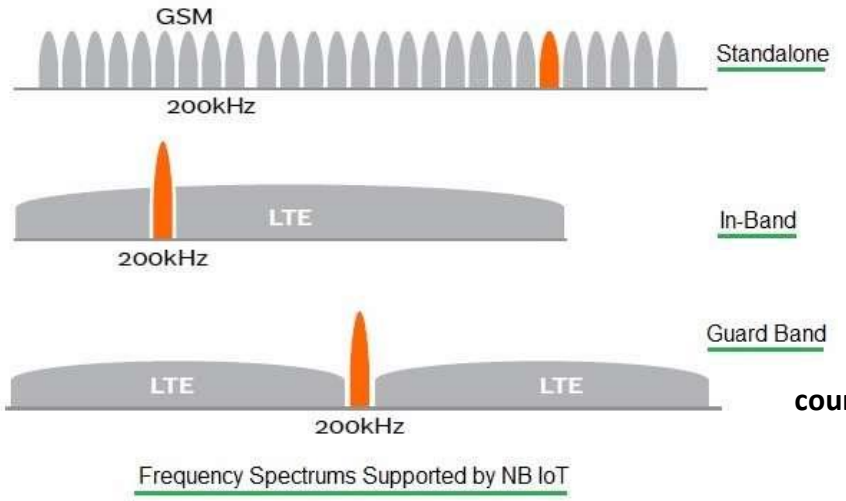
Orange and Bouygues making it a priority in EU

CSS	5/15km	$2-$5	5-10 years
BAND	433(A)/868(EU)/915MHz(US)		
BW	125/250/500kHz		
MOD	CSS		
PWR	20dBm		
LINK	157dB		
RATE	0.6-100kbps		

EOS ELECTRONIC SYSTEMS

NB-IoT – When The Operators Start Cashing In





Frequency Spectrums Supported by NB IoT

courtesy to ericsson.com

NB-IoT Chipsets available in 2017

Roll-out in Europe in 2018 (driven by Vodafone)

To use GSM infrastructure or existing LTE

OFDM		$5	
SC-FDMA	5/15km		10 years
BAND	700/800/900MHz + any LTE band		
BW	200kHz		
MOD	OFDM		
PWR	20dBm		
LINK	157dB		
RATE	0.33-22kbps / 100kbps (EU)		

EOS ELECTRONIC SYSTEMS

Other LPWA Technologies

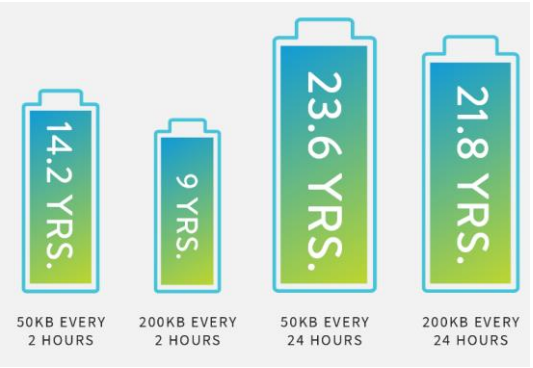
RPMA

Supported by INGENU simply genius

1MHz @2.4GHz license-exempt band

7.5km coverage range

DL/UL: 156/624 kbps



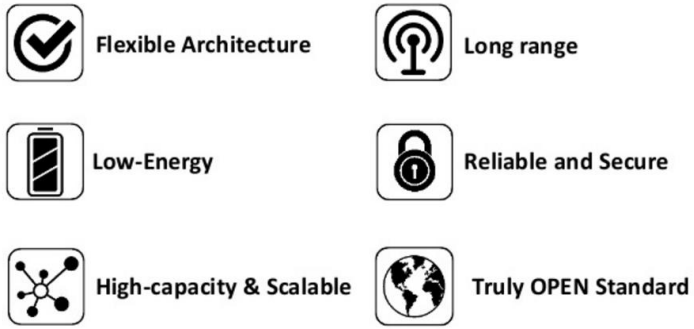
WEIGHTLESS™

Supported by ubiik

12.5kHz @900MHz license-exempt band

160dB link budget

DL/UL: 156/624 kbps



nwave

12.5kHz @900MHz license-exempt band

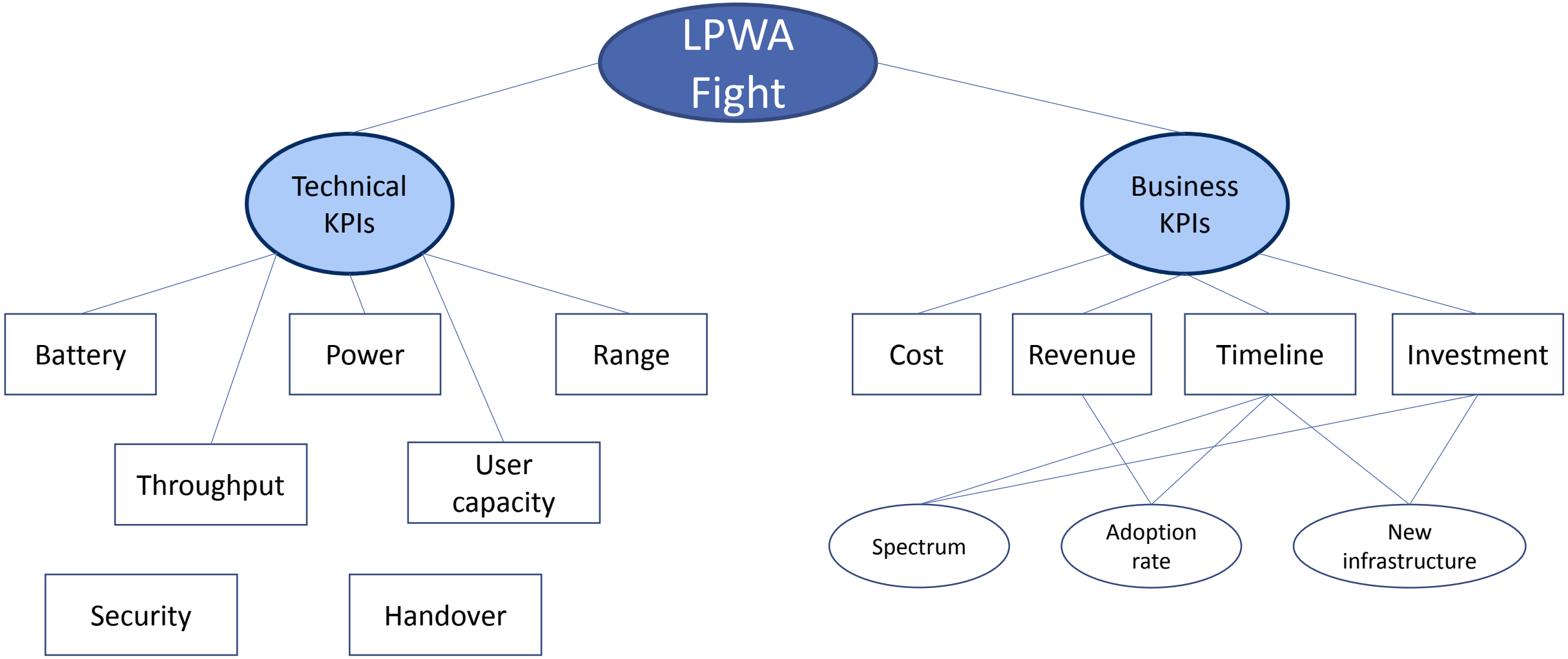
10km coverage range

DL/UL: 100bps

PARAMETER	GSM / CDMA	IEEE 802.15.4.MESH NETWORKS	NWAVE
Nodes served by base station	20,000	64,000	1,000,000
Typcial Commuincation Range	3/2 (km/mi)	30/100 (m/ft)	10/7 (km/mi)
Energy Radiation	2000 mW	10 mW	25-100 mW
Autonomous Operation (2.5Ah battery)	2 months	1-2 years	10 years
Signal Penetration within buildings	Average	Average	High
Cost of base station	High	Low	Low
Cost of Modem	High	$8-12	Low

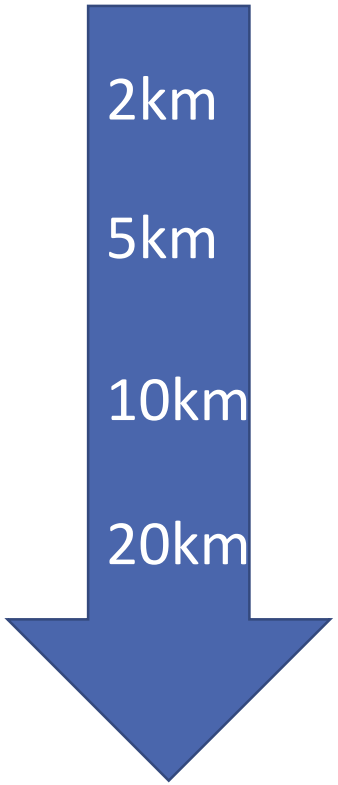
EOS ELECTRONIC SYSTEMS

Comparison Criteria



EOS ELECTRONIC SYSTEMS

Coverage Area



LoRa™ nwave

NB-LTE

SIGFOX
One network A billion dreams

High interference in unlicensed bands with no strong countermeasures

Marketed data rate is actually low at max range

Reliability of the link at max range

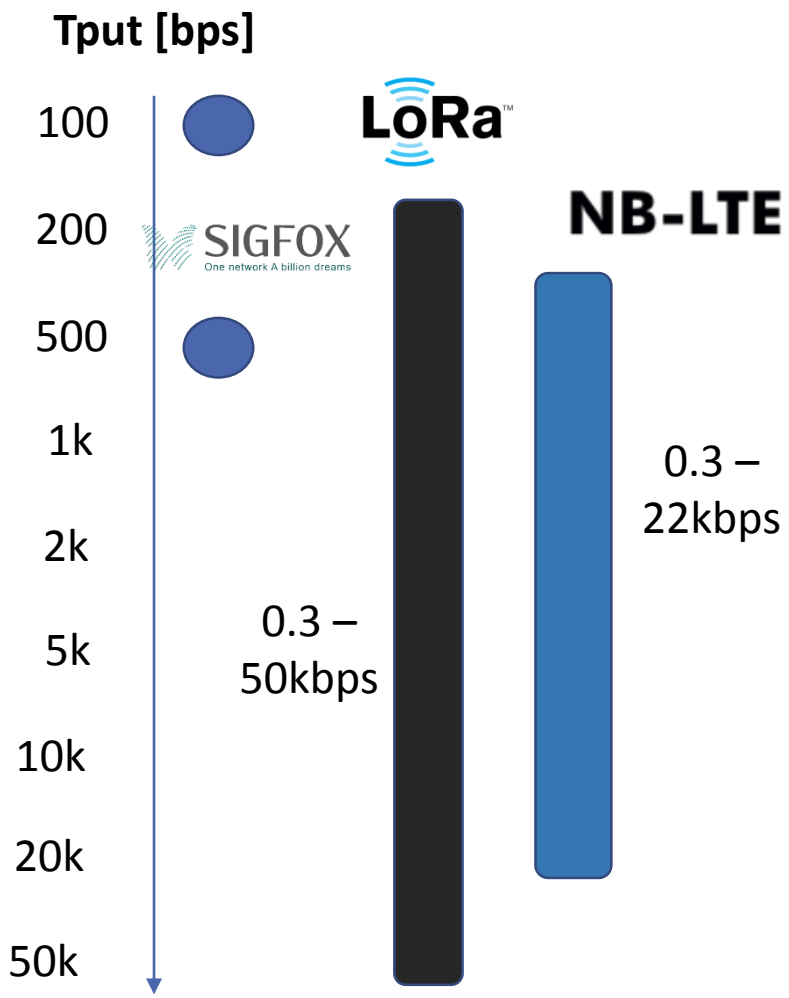
Reliability in NLOS scenarios

NB-IoT wins

(licensed spectrum)

EOS ELECTRONIC SYSTEMS

Throughput



Throughput will largely depend on channel conditions

Minimum requirements

- Frequency of reports
- OTA firmware update
- Debug capabilities
- Signaling (handover)
- Symmetrical

LoRa & NB-IoT win

(rate flexibility)

EOS ELECTRONIC SYSTEMS

Power Consumption

All technologies cover a span of **5-15 years**

NB-LTE

Actual numbers depend on:

- Battery
- Transmission power (range)
- Frequency of reports
- Application and sensor(s)

The power (consumption) of SOFTWARE:

- OS
- Sleep mode
- Algorithms

All win

(because we can't say otherwise)

EOS ELECTRONIC SYSTEMS

Security

- Tremendous importance
- Hijackers may inject false data in the network or access real data

	Sigfox	LoRa	NB-IoT
User authentication	Y (16-bit)	Y (32-bit)	MNO native security mechanisms
Communication	N	Unique Network key (EUI64) Unique Application key (EUI64) Device specific key (EUI128)	

LoRa & NB-IoT win

Time to Market

Technology readiness

SIGFOX
One network A billion dreams

The earliest solution

Sigfox – widest coverage (>90% France, > 90% Spain, penetrating US)

LoRa™
RPMA

NB-LTE
WEIGHTLESS™

Late arrivals

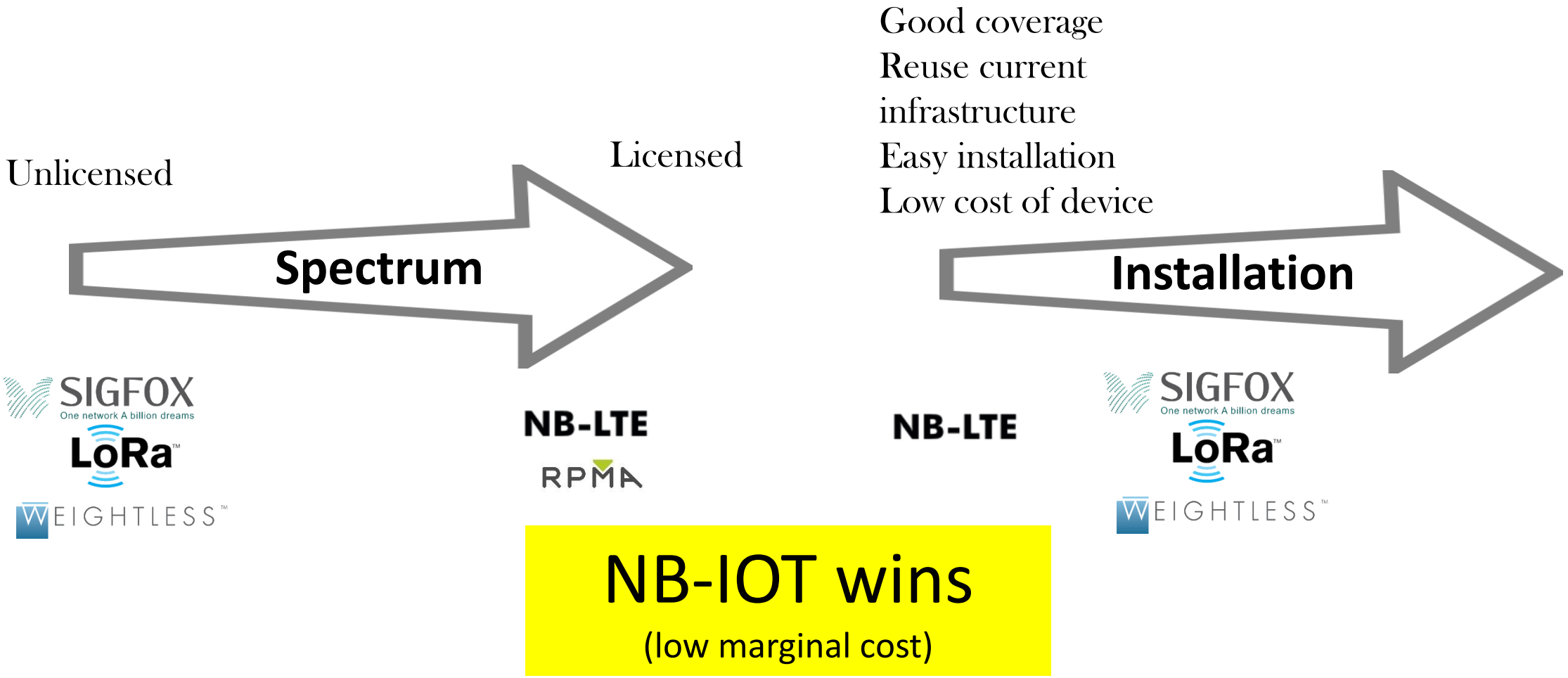
Slow growth
- Single vendor
- Operator exclusivity
- Closed standard

SIGFOX wins (for now…)

Fast growth
- Multiple vendors
- Multiple operators
- Open standard

EOS ELECTRONIC SYSTEMS

Investment Requirements



EOS ELECTRONIC SYSTEMS

Conclusions

- There is and will be no clear winner to the IoT race
- Impossible to meet all KPIs with one single technology
- Choice on connectivity will depend on the actual use case
- Aggressive marketing puts Sigfox ahead of its competitors
- NB-IoT will catch up in 2-3 years
- Time to market will triumph, harmonization will fall