Content

- C-IoT Insight
- NB-IoT Industry update
- NB-IoT Use Cases Ecosystem
IoT connectivity – A New look At Utility Opportunities

- **Health care**: $1 Trillion
- **Energy & Utilities**: $400Bn
- **Transport**: $104Bn
- **Buildings**: $22Bn
- **Education**: $344Bn
- **Smart Home**: $60Bn
- **Global Smart Envir**: $705Bn
- **Smart Technology**: $60Bn
- **Connected Vehicle**: $104Bn
- **Smart city**: $22Bn
- **Water**: $330Bn
- **Security, traffic**: $1.6Trillion

*Global estimations from 9 analytics agencies, eg. Ovum, GSMA, Gartner*

**Market by 2025**

*$11.1 Trillion*

**Estimated economic impact**

*Mc Kinsey Global Research 2015*
Why LPWA?
The Challenge - IoT Apps in Difficult RF Environments

- Indoors
- Metal Cabinets
- Battery Powered
- Wide Coverage Area
- Remote Locations
- Underground
C-IoT is designed to provide wide WAN coverage

- Re-use existing Cellular network Hardware + Spectrum
- Carrier-grade Reliability
- 3GPP 4G-Like Security
- Roaming

100K Connections/cell
20dB Deeper coverage
10 years Low power

- Wifi coverage
- LTE Coverage

Unlicensed IoT
C-IoT Coverage

- Unlicensed technology is for local coverage
- C-IoT is for wide coverage
NB-IoT: the best addressing the LPWA market

- **Wide Coverage:** 100x4G
- **High Quality Spectrum:** Licensed Spectrum
- **Massive Connection:** 100k/cell
- **Cost effective -- CAPEX:** Infrastructure reuse
- **Cost effective -- OPEX:** ~10 yrs battery
- **Cost effective -- Terminal:** $5 module

### Market ($100M) 2020

- **Meter:** 1,300 (1)
- **Parking:** 24 (8)
- **Tracing:** 210 (73)
- **Agriculture:** 150 (39)
- **Lighting:** 190 (27)
- **Monitoring:** 31 (18)
- **Livestock:** 64 (12)

### Comparison

- **2016:**
  - Meter: 320
  - Parking: 3.4
  - Tracing: 18
  - Agriculture: 35
  - Lighting: 24
  - Monitoring: 4.3
  - Livestock: 7.3

- **2020:**
  - Meter: 1,300
  - Parking: 24
  - Tracing: 210
  - Agriculture: 150
  - Lighting: 190
  - Monitoring: 31
  - Livestock: 64

### Global Cellular IoT connections

- **High Speed (>10Mbps):** Robotics, Self-Driving Car, etc.
- **Mid-speed (<1Mbps):** Smart Home, Connected Car, etc.
- **Low speed (<100kbps):** Smart Metering, Smart City Applications

**NB-IoT 4.2B connections @ 2023**
NB-IoT -- LTE technology with 200KHz System Bandwidth

**Downlink**
- OFDMA
- 15KHz * 12 = 180KHz
- Peak Rate: ≈ 200Kbps

**Uplink**
- SC FDMA
- singletone
  - 15KHz
  - Peak Rate: ≈ 22.4Kbps
- multitone
  - 15K * 12 = 180KHz
  - Peak Rate: ≈ 200 Kbps

- Narrow band match small package IoT service model
- Accommodate large number IoT traffic model terminal
- Fit in-band scenario
NB-IoT -- Deep Coverage: Main Features

1. Power Spectrum Density Boosting
   - Typical Case
     - IoT Device: 200mw
     - Data Package (e.g. 100 byte)
   - 2G/3G/LTE Solution
     - 180 KHz
     - Average Power = 200mW/180kHz
     - 36 times/17dB
   - NB IoT Solution
     - 3.75 KHz
     - Average Power = 200mW/3.75kHz

2. Repetition
   - UP to 16 Times Repetition
   - 3~12dB

3. UL Receive Diversity
   - GSM/GPRS 1T1R
   - NB IoT 1T2R
Energy Saving: PSM + eDRX

PSM (Power Saving Mode)

- NB-IoT UE Power
- Idle State
- Paging
- Up to 310 hours

Network determines cycle according to Terminal service type.

eDRX (Extended DRX)

- DRX Cycle: 1.28s
- eDRX Cycle: up to 2.92h

PTW: Paging Transmission Window
NB-IoT -- Low Cost: Chipset/Module

**Cat-4**

- BB
- 2RX
- 1TX
- RF
- MMMB PA
- PMU
- Flash/RAM

**Cat-0**

- BB
- 1RX
- 1TX
- RF
- MB PA
- PMU
- Flash/RAM

**OneAir-IoT**

- BB
- 1RX
- 1TX
- RF
- PA
- PMU
- Flash/RAM

**Key Terms:***

- MMMB: Multi-Mode, Multi-Band PA
- MB: Multi-Band
- BB: Baseband
- PMU: Power Management Unit
- PA: Power Amplifier
- SOC: System on Chip

**Features:***

- SOC Solution
- Half Duplex RF/Single Antenna
- Reduced Memory
- Narrow Band/UL Single-Carrier Modulation
- Simplified Process
5 USD Module is Competitive for LPWA Market

- CAT4: $30
- CAT1: $15
- CAT0 (MTC): $15
- CAT-M (eMTC): $10
- Sigfox: $9
- GPRS: $8
- LoRa: $8
- NB-IoT (OneAir-IoT): $5

ONLY NB-IoT can do it
R14: Positioning to simplify device requirement

**NB-IoT Tracking Technologies Overview:**

- **GPS + NB-IoT (Connectivity)**
  - Device cost: ~50USD
  - Accuracy: 10m
  - Latency: 30s
  - Power consumption: 0.3mAh/Report

- **NB-IoT (OTDOA)**
  - Device cost: ~40USD
  - OTDOA: 30~50m
  - Latency: 10s
  - Power consumption: 0.2mAh/Report

**BaaS Business Model:**

- Kids tracking (GizmoPal)
  - Monthly service fee: 5USD

- Kids tracking (Filip2 Tracker)
  - Monthly fee: USD10 for voice and data
R14: Multicast to improve network performance

Assumption: 100 device, full package: 750KB, diff package: 100KB

Dependency:
- Need chipset support broadcasting
- Need add MBMS GW & BM-SC

Uni-cast full FOTA: 3.3 days
Uni-cast diff FOTA: 0.5 days
Multi-cast FOTA diff FOTA: 30 minutes
R14: Throughput evolution: NB-IoT to replace GPRS
eMTC to replace CAT-1 and 3G M2M

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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<tbody>
<tr>
<td>OBD</td>
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<tr>
<td>POS</td>
<td>GPRS</td>
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<td>Pet tracking</td>
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<tr>
<td>Logistic tracking</td>
<td>NB-IoT</td>
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<tr>
<td>Smart parking</td>
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<tr>
<td>Street light</td>
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<tr>
<td>Smart metering</td>
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DL: 80kbps
UL: 106kbps
DL: 21.25kbps
UL: 15.62kbps
NB-IoT/eMTC Standard’s evolution path to 5G

<table>
<thead>
<tr>
<th>NB-IoT</th>
<th>eMTC</th>
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<tbody>
<tr>
<td><strong>Rel-14</strong></td>
<td><strong>Rel-14</strong></td>
</tr>
<tr>
<td>• Positioning: E-CID OTDOA</td>
<td>• Positioning: OTDOA</td>
</tr>
<tr>
<td>• SC-PTM</td>
<td>• SC-PTM</td>
</tr>
<tr>
<td>• 14dBm output power</td>
<td>• 5MHz/20MHz bandwidth</td>
</tr>
<tr>
<td>• Peak throughput improvement (DL 114kbps/UL 142.5kbps)</td>
<td>• VoLTE coverage improvement (5dB)</td>
</tr>
<tr>
<td><strong>Rel-15</strong></td>
<td><strong>Rel-15</strong></td>
</tr>
<tr>
<td>• TDD NB-IoT</td>
<td>• Capacity improvement: Sub-PRB eMTC (45KHz)</td>
</tr>
<tr>
<td>• RRM measurement, latency improvement</td>
<td>• 64QAM</td>
</tr>
<tr>
<td>• NPRACH enhancement</td>
<td>• Low UE output power</td>
</tr>
<tr>
<td>• Differ group QoS</td>
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</tbody>
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Technology: NR
- LTE to cover high band and low band

mMTC
- mMTC NR will not be considered until R17;
- NB-IoT will be used to cover 5G mMTC use case before R17

Technology: eMBB
- LTE

URLLC
- NR
- NR2
Industry Testing to Guarantee Inter-vendor operability

Unified protocol

- eNB
- HSS
- MME
- MSC
- SMS-SC/GMSC/IWMSC
- S-GW
- P-GW
- T6a
- S1
- S11
- S5/S8
- SGi
- IoT Platform
- APP Server
- Unified protocol

IODT → MVI → Commercial

Test between vendors → Test in operator’s lab → Verification in commercial network
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Huawei Chipset and Network are Commercially Available

High Integration
- SOC: BB + RF + PMU + AP/SP/CP + eFlash + SRAM
- Three ARM Cores: AP+CP+SP

Boudica 120 (3GPP R13)
- Bands: 5/8/20/28
- DL 21.2Kbps / UL 15.6Kbps
  - PSM / eDRX / cDRX
  - Coverage Level Selection
  - Paging
  - 20dB Coverage Gain
  - SMS, IP / Non-IP
  - Single Tone
  - Application for 3rd party integration (2017 Q2)
    (TUP/CoAP/FOTA/LWM2M/DTLS/TCP/eSIM)

Boudica 150 (3GPP R13&R14)
- Bands: 5/8/20/28/3/1
- DL 80Kbps / UL106Kbps
  - Positioning (OTDOA)*
  - Multicast (SC-PTM) *
  - Data over user-plan*
  - Single Tone / Multi-tone
  - AP Open for 3rd party

* Planning Feature

NB-IoT
- SRAN12.0
  - GA
  - Project Starts with Mature Chipset
- SRAN12.1
  - Global Commercialization
  - eMTC
  - trial

eMTC
- SRAN12.1
  - GA

SRAN12.1
- GA

Global Commercialization
- GA

Project Starts with Mature Chipset
- GA
Module Readiness for NB-IoT Device Integration

- NB-IoT Module readiness in 2016
- NB-IoT module received Global Certification Forum certification

- Ublox:SARA-N2
- Quectel:BC95

More chipsets and modules will be ready in 2017

- Qualcomm
- Intel
- Sequans
- Monarch
- MDM 9206
- XMM 7315
- Sierra Wireless
- SIMCom
- Telit
- Gemalto
Deutsche Telekom rollout NB-IoT: 8 countries in Europe in 2017

Commercial plan:

NB-IoT rollout across Europe in 8 countries in 2017

- Germany: commercial launch in 2017Q2
- Netherland: Nationwide coverage in 2017

Use cases:

- Smart building:
  - Heat consumption
  - Water consumption
  - Intelligent smoke alarms
- Parking

Develop ecosystem through NB-IoT Prototyping Hub

Support plan for startups:

- Demo Kit
- Lab trial
- Field trial
- Roll out

Examples of use case innovation through prototyping hub:

- Bee hive monitoring
- Smart water management
Vodafone announced the commercialization of NB-IoT

- 4 countries in Europe (Germany, Ireland, Netherlands and Spain) will commercially launch NB-IoT in 2017.
- Announced the commercialization of NB-IoT on 23rd Jan 17
- 1000 sites activated NB-IoT in Spain by the end of March 2017
- Took just a few hours to deploy NB-IoT with software upgrade in Valencia
- Madrid, Valencia, Barcelona are covered, Plan to cover 6 cities in 2017H1
China Unicom: 800+ Sites Activated NB-IoT in Shanghai

Shanghai Unicom: 800+ base stations covered Shanghai in 2016Q4

Network readiness accelerates the development of vertical customers

- Parking operator
- Gas Utility
- Fire center
- Smart Parking
- Smart Gas Meter
- Smart Fire Protection

11 use cases ready

- Pre-commercial announced

- Street light
- Door lock
- Tracker
- Pipe monitor
Use cases

- 100 NB-IoT bicycles test in Beijing University in Q2 2017
- 100K bicycles in Beijing city by September 2017
- China Telecom to provide NB-IoT coverage in whole Beijing by June 2017

- Mar 22 2017, Shenzhen water utility announced commercialization;
- 1200 meters (phase 1) running in live network;

2017H1, NB-IoT will be enabled in L850 to achieve national wide coverage.
Huawei will Deploy 30+ NB-IoT Commercial Networks in 20+ Countries in 2017

Representing 32% of Global Population & 10% of Countries
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Huawei Global NB-IoT Open Labs Accelerates Industry Development

• Openness: Empower Vertical Industry
• Innovation: Foster Applications

Global NB-IoT Open Labs
**NB-IoT Ecosystem is Taking Off**

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<tr>
<th>Industry</th>
<th>Partners</th>
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<tbody>
<tr>
<td>Smart Water</td>
<td>40+ partners from 20+ industries</td>
</tr>
<tr>
<td>Smart Agriculture</td>
<td>Smart Gas, Smart Grid, Smart Lighting, Smoke Detector, Air Quality</td>
</tr>
<tr>
<td>Asset Tracking</td>
<td>Bicycle Sharing, White Goods, Healthcare, Electronic Manufacturing Service</td>
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<tr>
<td>Pet Tracking</td>
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**NB-IoT Ecosystem Partner List**

Issue 2.0
eLTE-IoT Based on ISM Band

Meets Regional ISM Requirements

China
- 470 MHz to 510 MHz
- EIRP: 17 dBm/50 mW

USA
- 902 MHz to 928 MHz
- EIRP: 36 dBm (> 50 channels)
  30 dBm (< 50 channels)

Europe
- 863 MHz to 870 MHz
- ERP: 14dBm

For use with Industrial IoT devices

Control equipment
- meters
- Trackers

Sensors