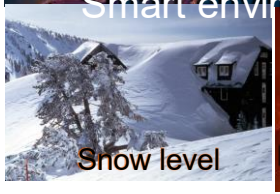
Low-Power Cellular IoT Devices

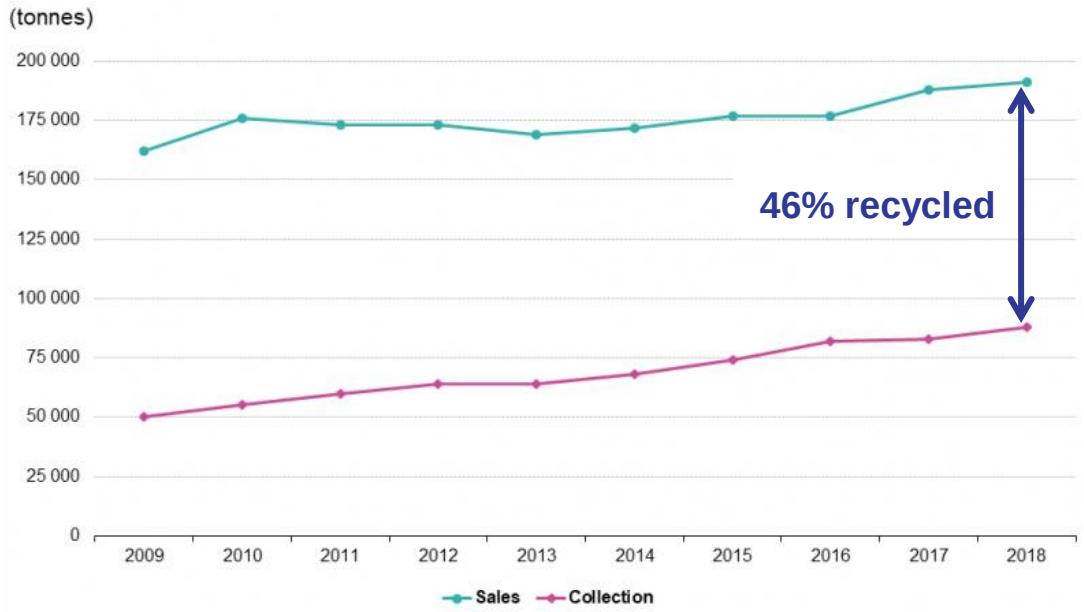
Nafiseh Mazloum, Sony Research Center Lund

MASSIVE INTERNET of THINGS CONNECTIVITY



BATTERY-FREE COMMUNICATION FOR MASSIVE INTERNET of THINGS CONNECTIVITY

Sales and collection of portable batteries and accumulator, EU-27, 2009-2018



Note: Rounded estimates
Source: Eurostat (online data code: env_waspb)

eurostat

- Changing battery is a bottleneck, e.g., a trillion-device world with 10-year battery life-time means ~274 billion battery changing everyday.
- In 2018, 191 000 tonnes of portable batteries were sold in the EU; 88 000 tonnes of used portable batteries were collected as waste to be recycled.

REQUIREMENTS ON CELLULAR CONNECTIVITY FOR IOT

Low complexity low-cost device

- ❑ Sensors, actuators, and similar devices,
- ❑ usually do not require the wideband operation of LTE.

Long (10+ years) battery life

- ❑ Devices are often battery-powered and
- ❑ battery life needs to last at least the device life-time.

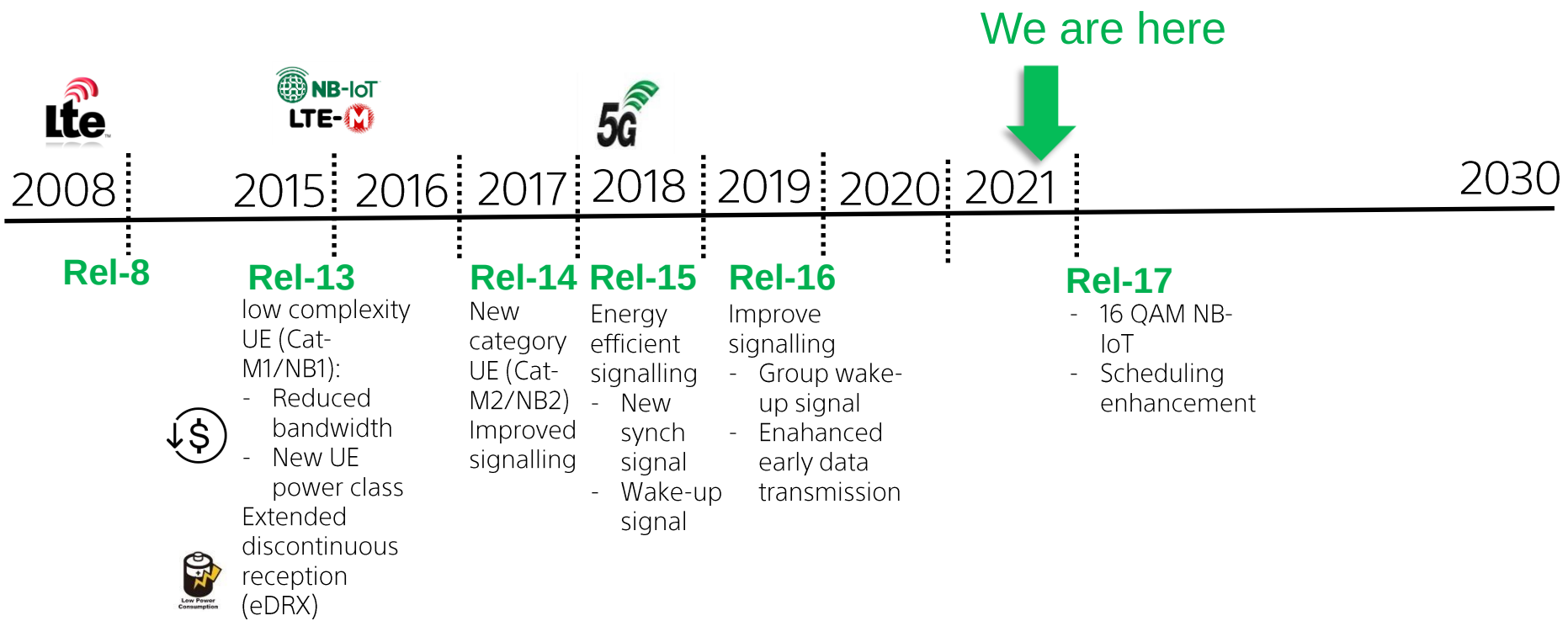
Extended (+20dB) coverage

For devices located in
- ❑ rural area,
- ❑ deserted area, or
- ❑ basement of a building.

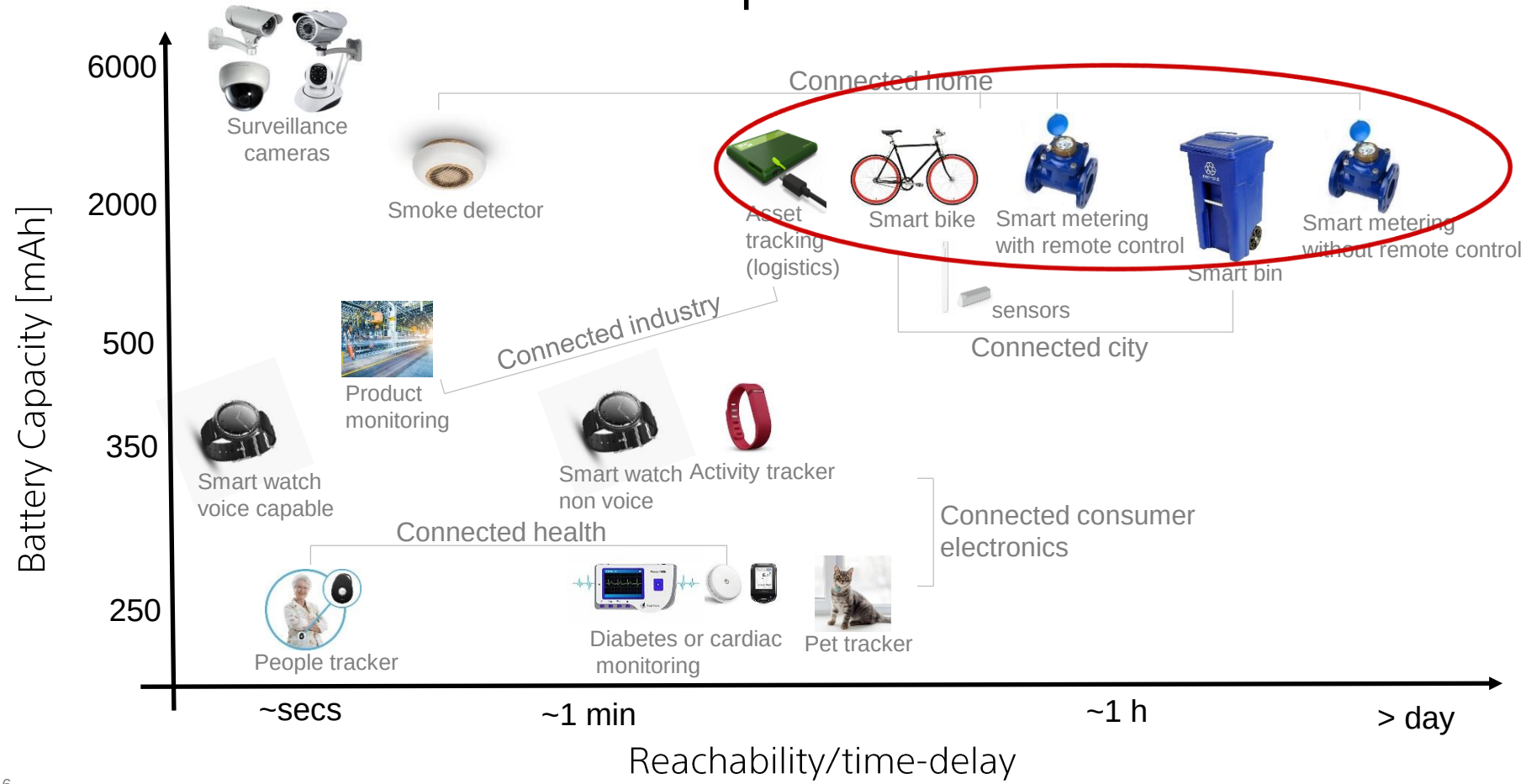
Massive number of devices

- ❑ One million IoT devices per square kilometer
- ❑ Covering all types of communication between machines.

EVOLUTION OF CELLULAR CONNECTIVITY FOR IOT



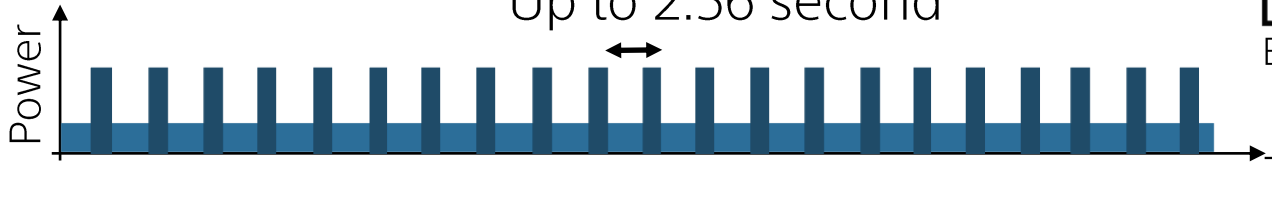
Cellular IoT Use cases – Example



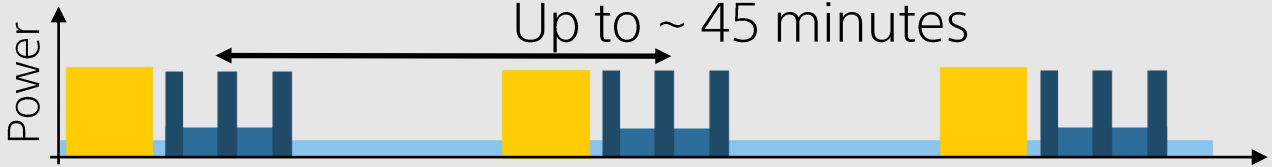
EXISTING POWER SAVING FEATURES

SONY

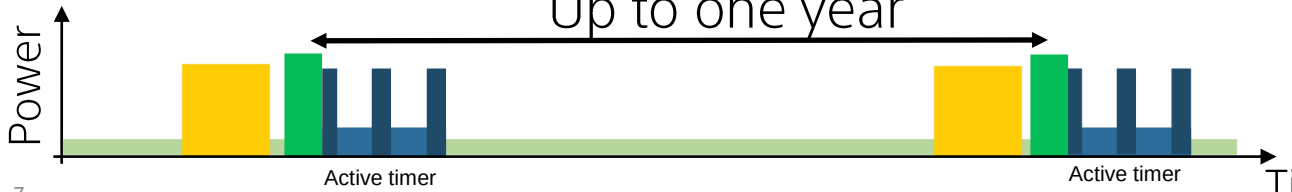
Discontinous Reception (DRx)
Up to 2.56 second

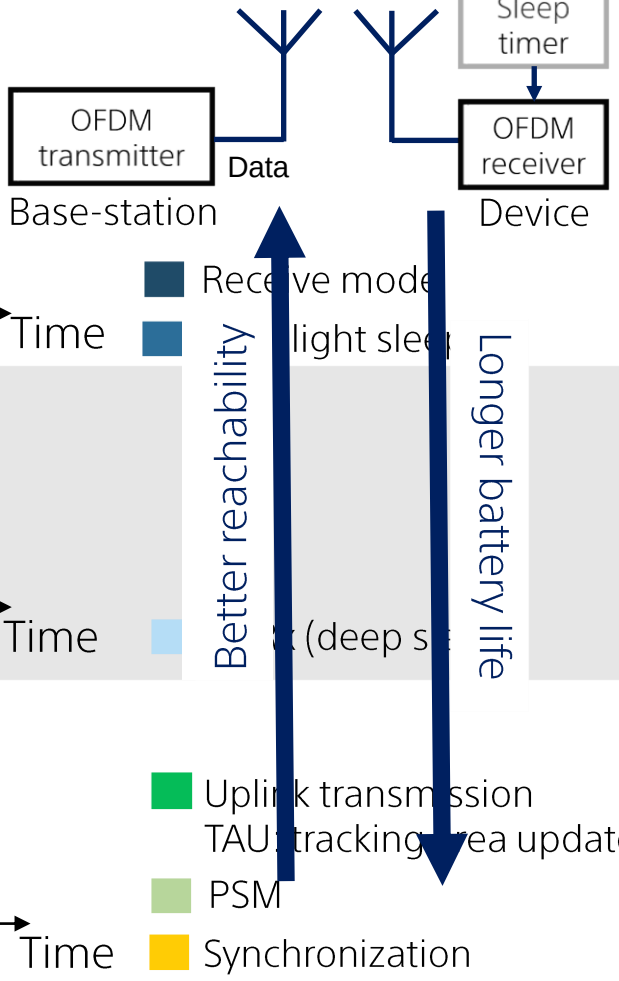


Extended DRx (eDRx) – Rel. 13
Up to ~ 45 minutes



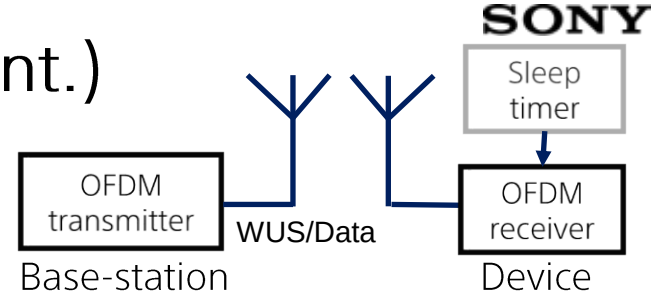
Power Saving Mode (PSM) – Rel. 12
Up to one year





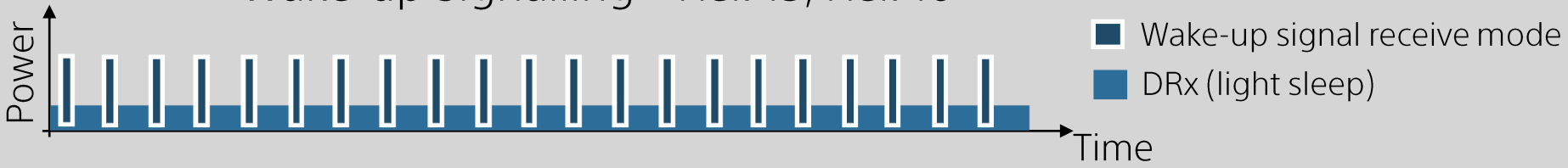
EXISTING POWER SAVING FEATURES (cont.)

- Lower power consumption during listening, looking for a simpler wake-up signal
- Lower synchronization cost, a compact re-synchronization signal



WUS: wake-up signal

Discontinous Reception (DRx) and Wake-up Signalling – Rel. 15, Rel. 16



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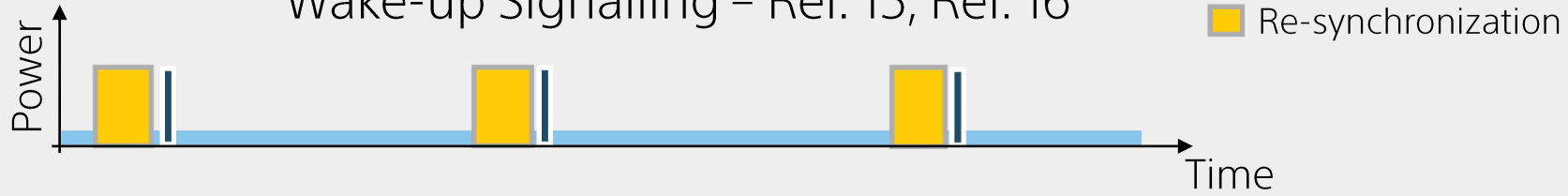
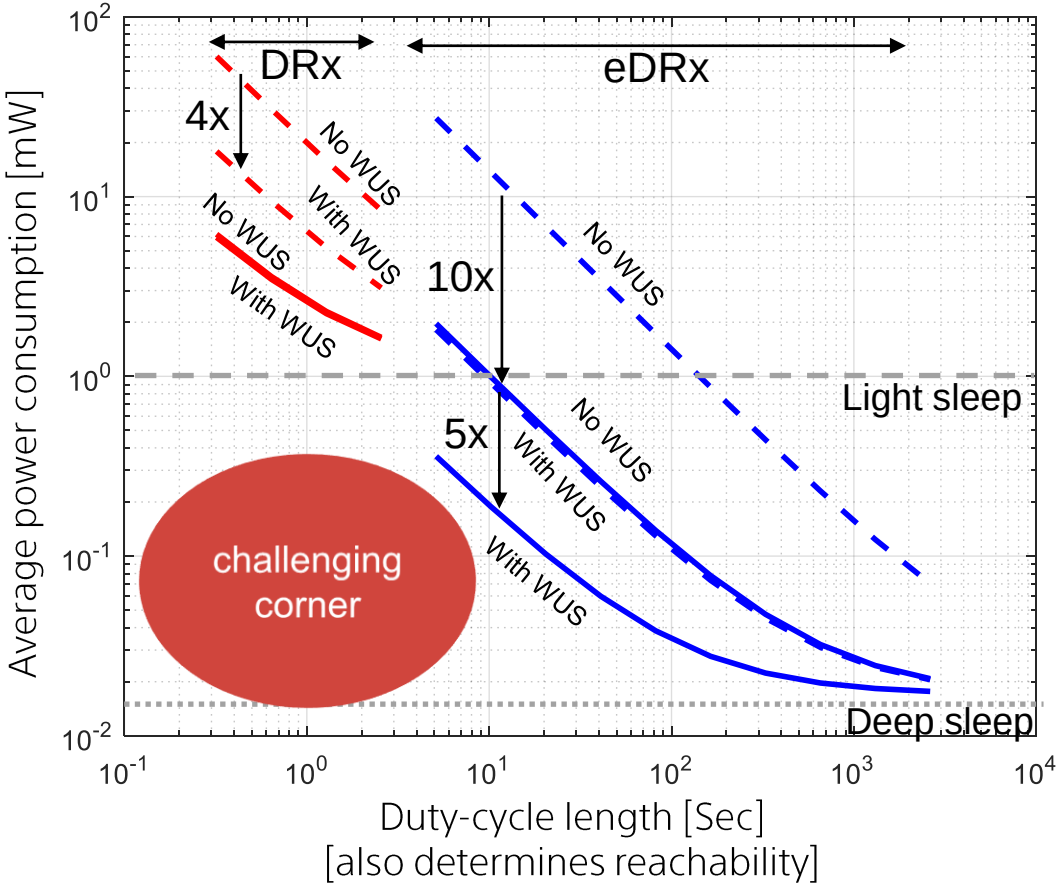


POWER CONSUMPTION CHARACTERISTICS



Normal coverage

Extended coverage

Nafiseh Mazloum, Dripta Ray, Ratna Pavan Kumar Ponna, Ove Edfors "Taking Cellular IoT Energy Efficiency to the Next Level", Asilomar Conference 2019

REQUIREMENTS ON CELLULAR CONNECTIVITY FOR IOT NR TRACK

SONY

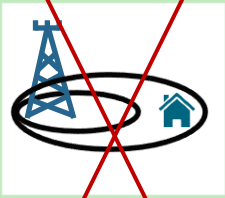
Low complexity low-cost device

- ❑ **IWSN, wearables, and surveillance cameras**
- ❑ usually do not require the wideband operation of **NR, with max. BW ~ 20MHz**.

Long ~~(10+ years)~~ battery life

- ❑ Devices are often battery-powered and
- ❑ **Battery life-time:**
  - ❑ **up to 1-2 weeks**
  - ❑ **several years**

~~Extended (+20dB) coverage~~



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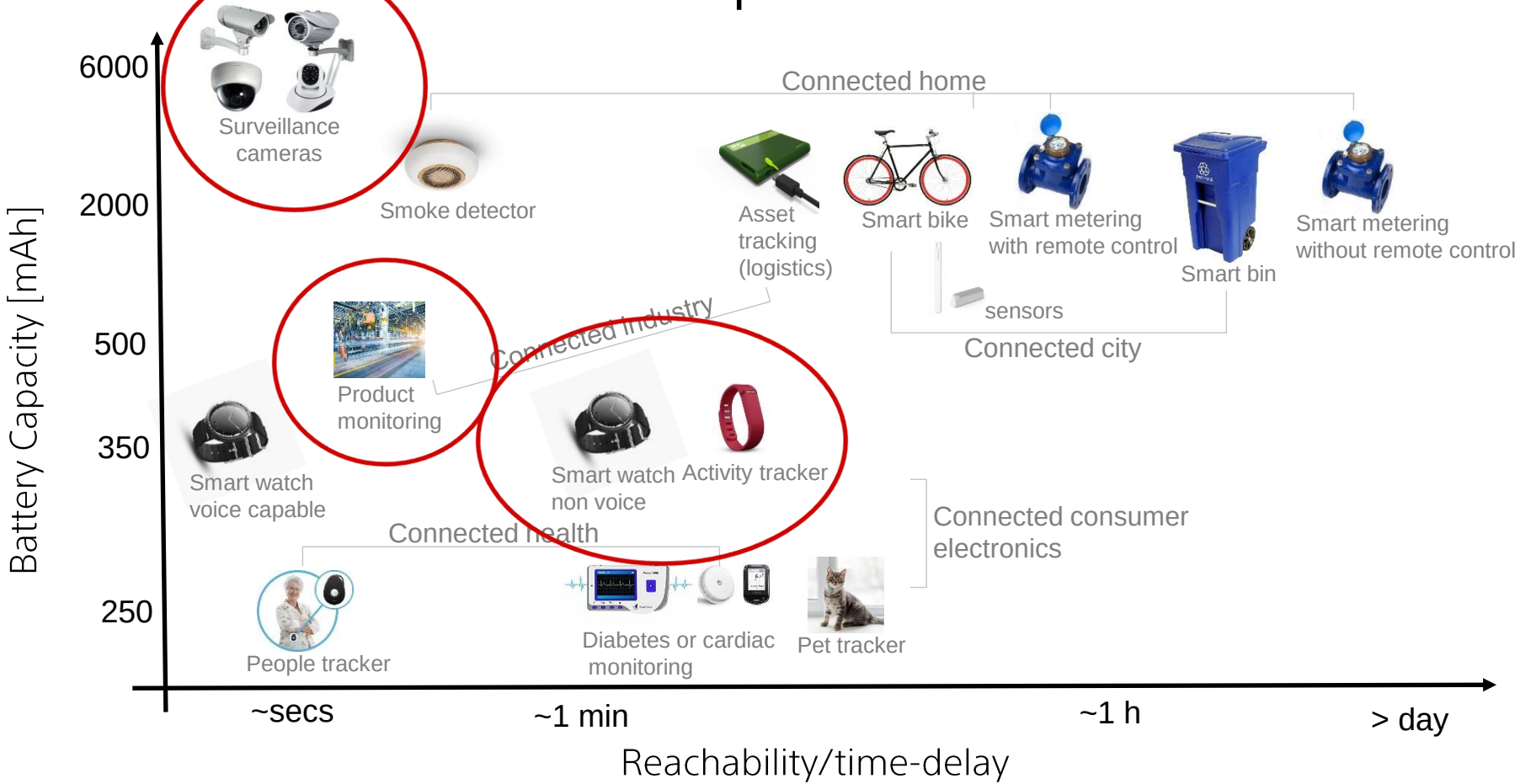
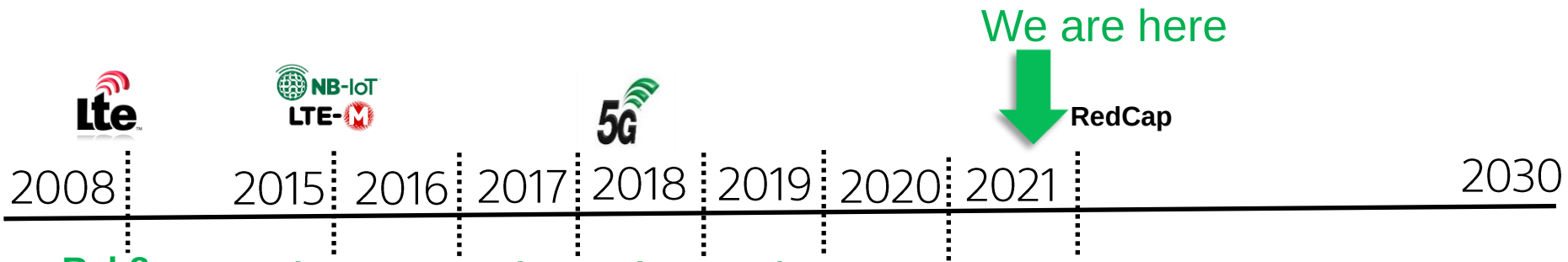


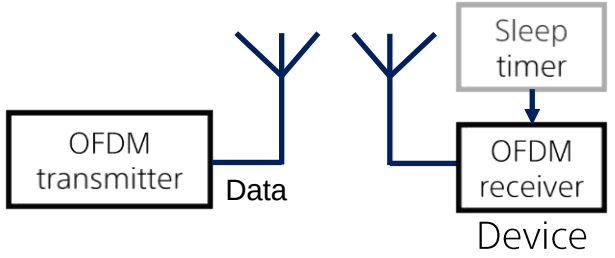
EVOLUTION OF CELLULAR CONNECTIVITY FOR IOT

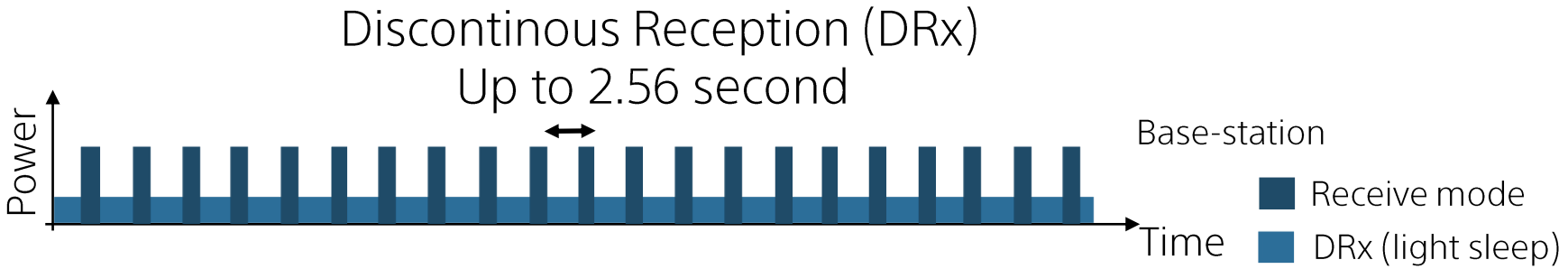


Key features for RedCap:
- Reduced bandwidth
- Reduced no. of MIMO layer
- Reduced RX branches
- Relaxed modulation order
- Half-duplex operation

EXISTING POWER SAVING FEATURES

SONY





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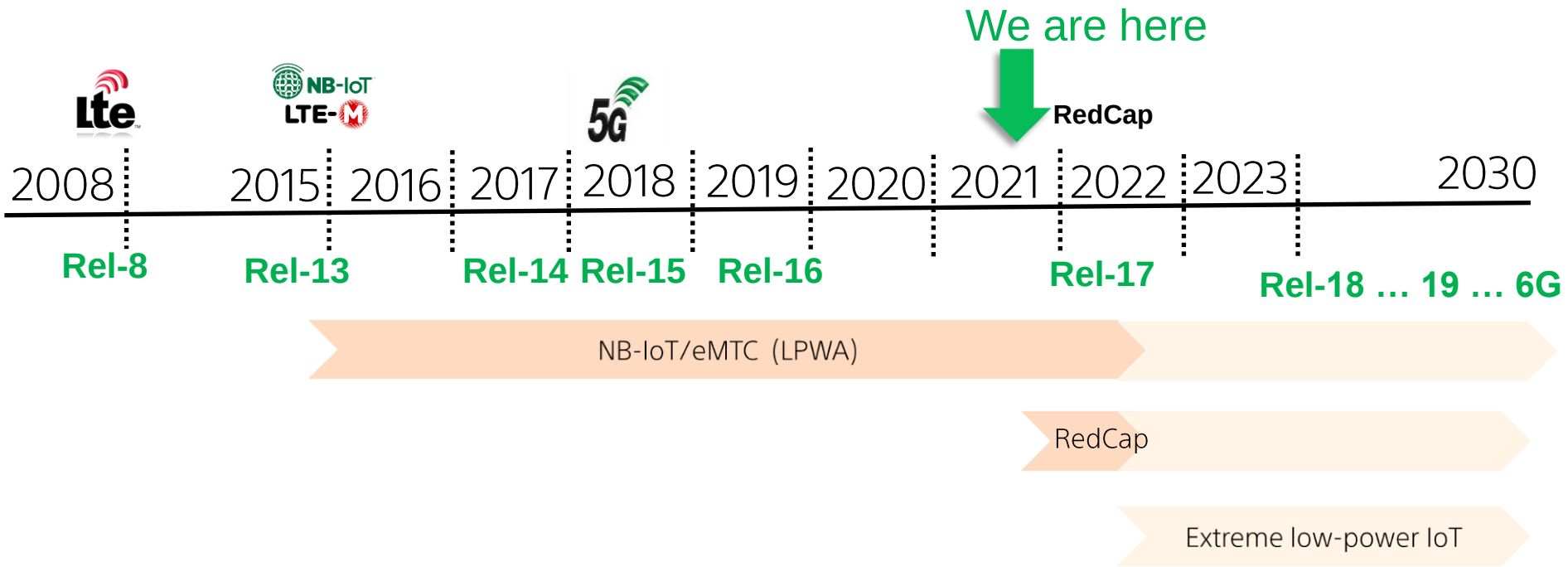

- Need for new solutions and mechanisms to support use-cases for Rel-18 and beyond.

Topics on the table for potential inclusion

- Extended discontinous reception (DRx) for RedCap devices
- Low-power wake-up receiver/signal
- Protocol enhancements to support operation on intermittently available energy harvested from the environment
- Further reduced complexity and cost reduction
- Support of backscattering communication
- Support of wireless power/energy transfer
- Completely new system design to achieve the extremely low power consumption, including simplified PHY and simplified protocol design.


SONY