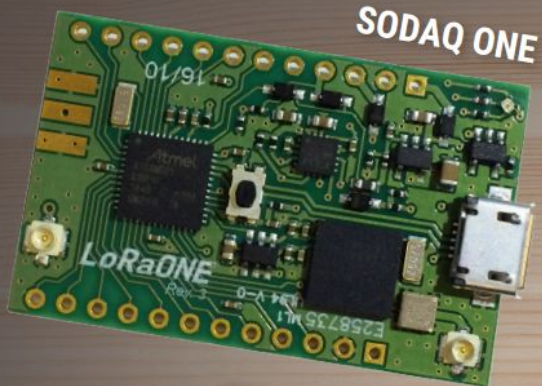


SODAQ

Wifi: SODAQ_GUEST
Password: autonomo



NB-IoT Workshop: <http://iot.sodaq.com>



1950
5000

1975
10,000

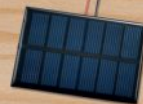
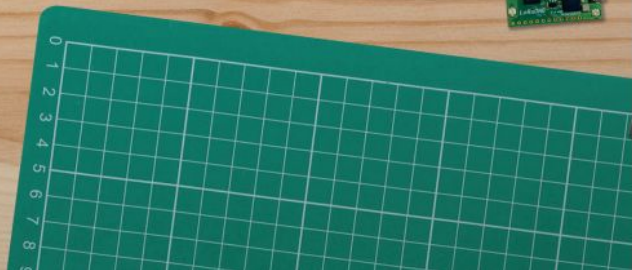
2003
500 million

2009
2,5 billion

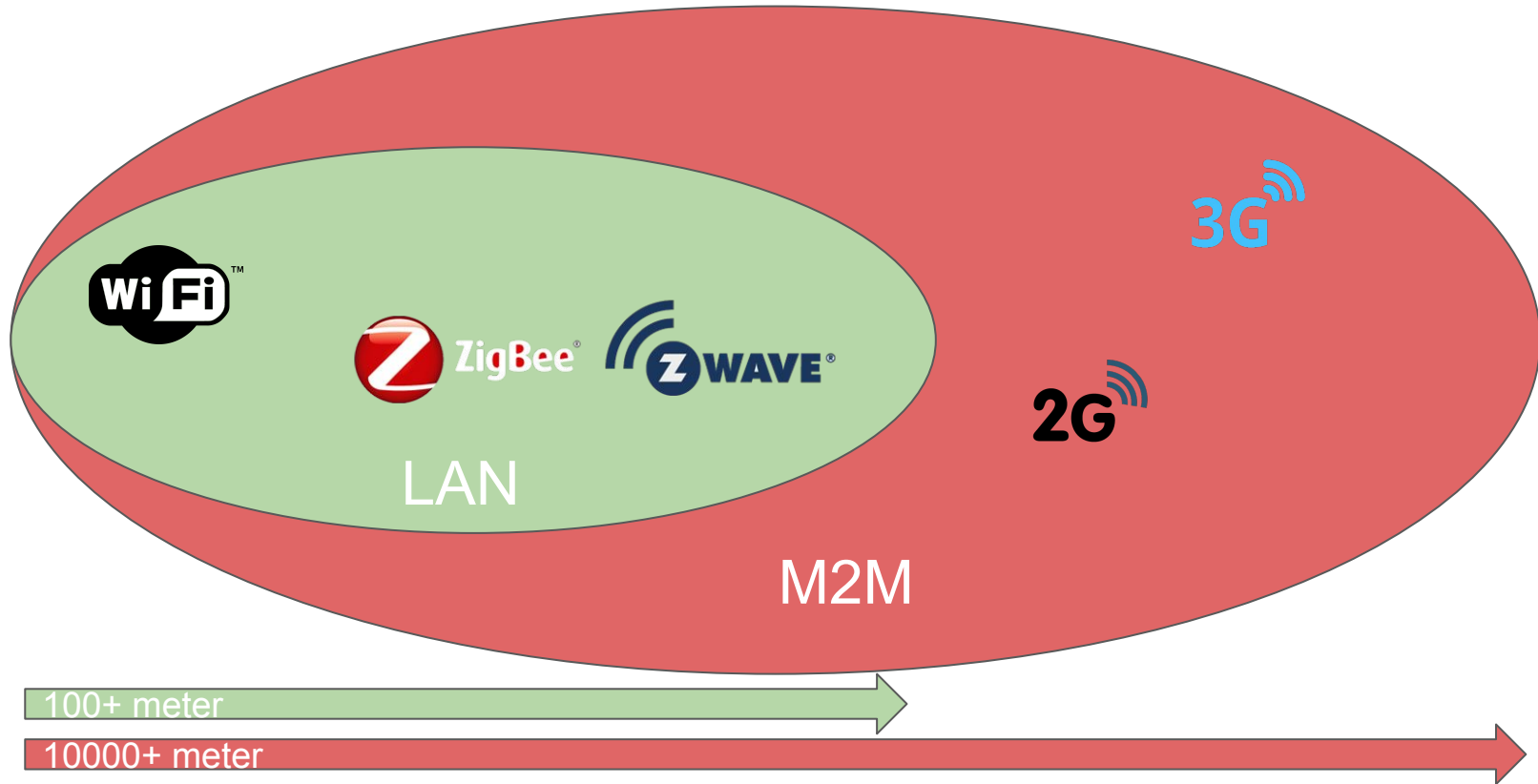
2014
10 billion

2020
50 billion

2050
>100 billion

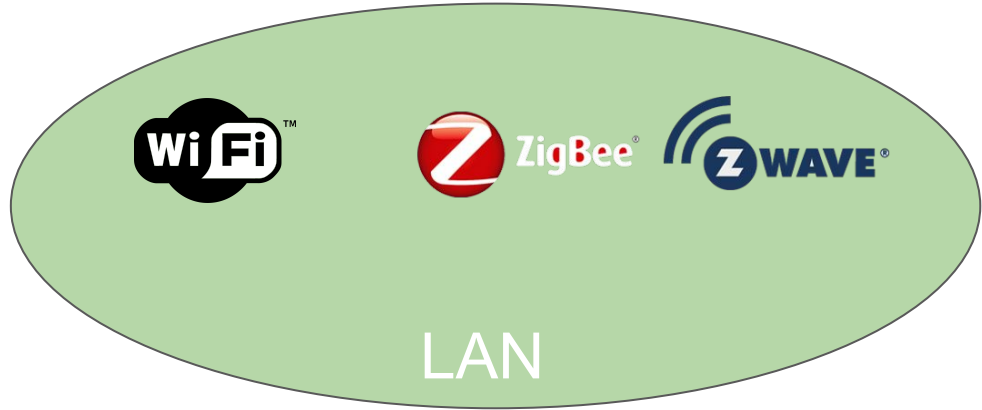


The IoT landscape 5 years ago



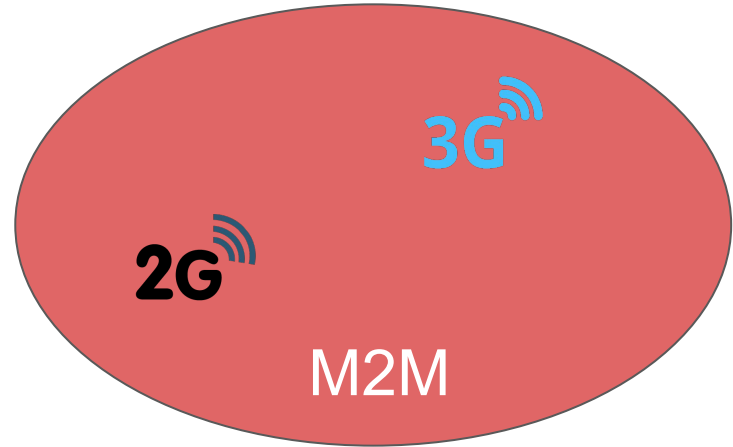
Indoor Things

- home automation
- often mains powered



Outdoor things

- Power hungry
- Long time to establish session
- Not really suitable for battery power



And then there was Sigfox

- First LPWAN network
- Unlicensed spectrum
 - 868 MHz Europe
 - 902 MHz USA
- Ultra Narrow Band
- 12 bytes data payload
- 140 messages per day
- Simplex, one way traffic



and LoRa

- Same unlicensed spectrum as SigFox
- Spread spectrum
- 51 bytes payload
- ~ 300 messages per day upload
- ~ 30 messages per day download



And now: NB-IoT

- Regulated (Licensed) spectrum
 - no duty cycle limits
- Extreme good coverage
 - > 12000 cells in the Netherlands
- Deep indoor penetration
- 20dB better than GSM



and LTE-M

- Regulated (Licensed) spectrum
 - no duty cycle limits
- Extreme good coverage
 - > 10000 cells in the Netherlands
- Good indoor penetration
- Seamless handover
- Higher power consumption than NB-IoT

SIGFOX



LoRa



**NB LTE-M
Rel. 13**

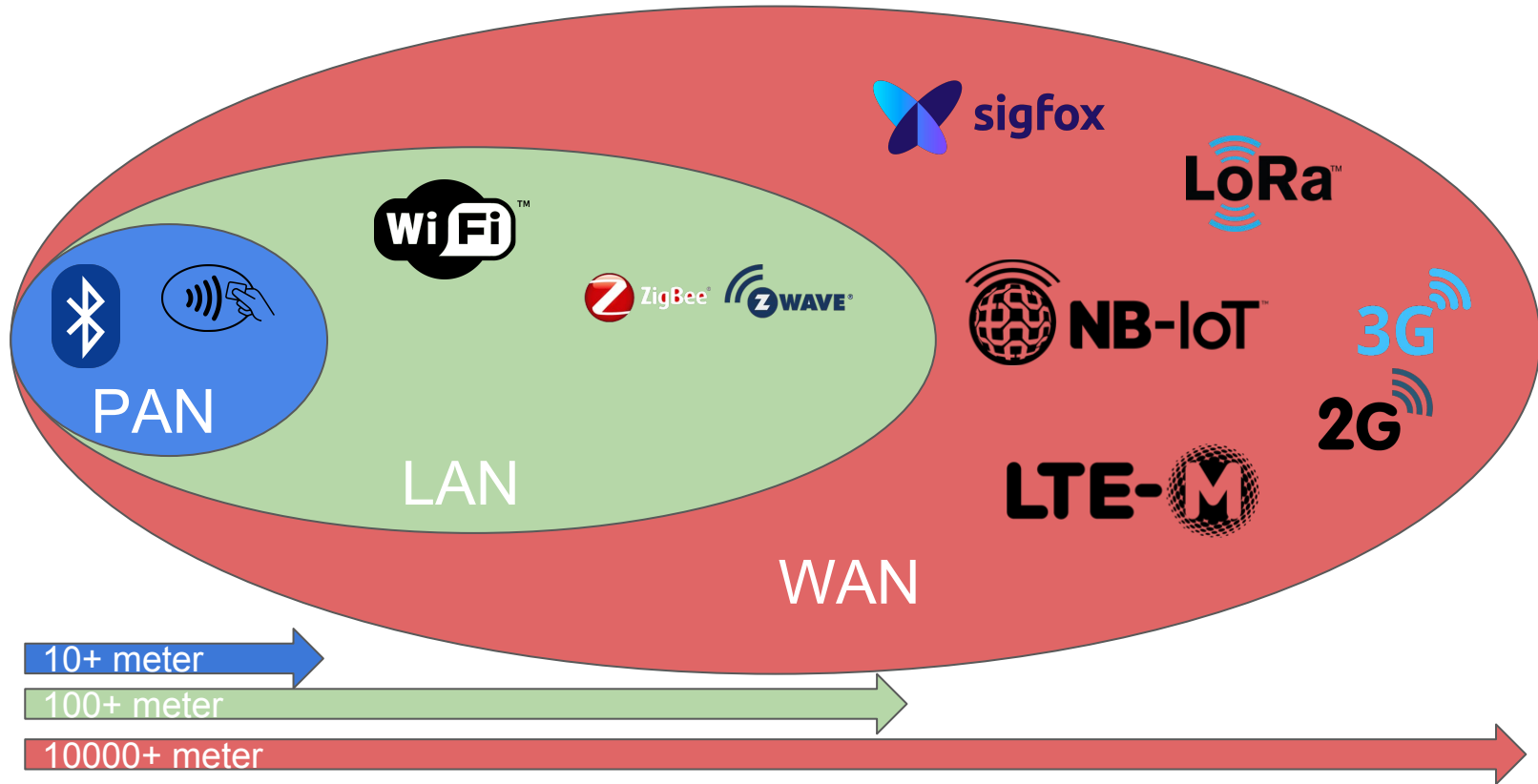


**LTE-M
Rel. 12/13**



Range (outdoor) MCL	<13km 160 dB	<11km 157 dB	<15km 164 dB	<11km 156 dB
Spectrum Bandwidth	Unlicensed 900MHz 100Hz	Unlicensed 900MHz <500kHz	Licensed 7-900MHz 200kHz or shared	Licensed 7-900MHz 1.4 MHz or shared
Data rate	<100bps	<10 kbps	<150kbps	<1 Mbps
Battery life	>10 years	>10 years	>10 years	>10 years

The IoT landscape today



LTE-M, a 3GPP-based IoT solution

- 4G** Standardized evolution of 4G LTE
-  Inband deployment in existing LTE band 800/1800 MHz
-  Implemented via 4G networks software upgrade
-  SIM & eSIM* encryption and authentication
-  Compatible with existing M2M data roaming model
- Short roll-out time and low deployment costs

LTE-M key strengths

-  Cat-M1 device support
-  Low cost modules (Target ~ 5\$)
-  Power optimisation features: Power Saving Mode, eDRX
-  Extended coverage & deep indoor
-  Real-Time Bi-directional link
-  Half/full mode (max 380 kbps/1 Mbps)
-  High speed mobility support & connected mode handover
-  VoLTE support*

LTE-M verticals & target use cases

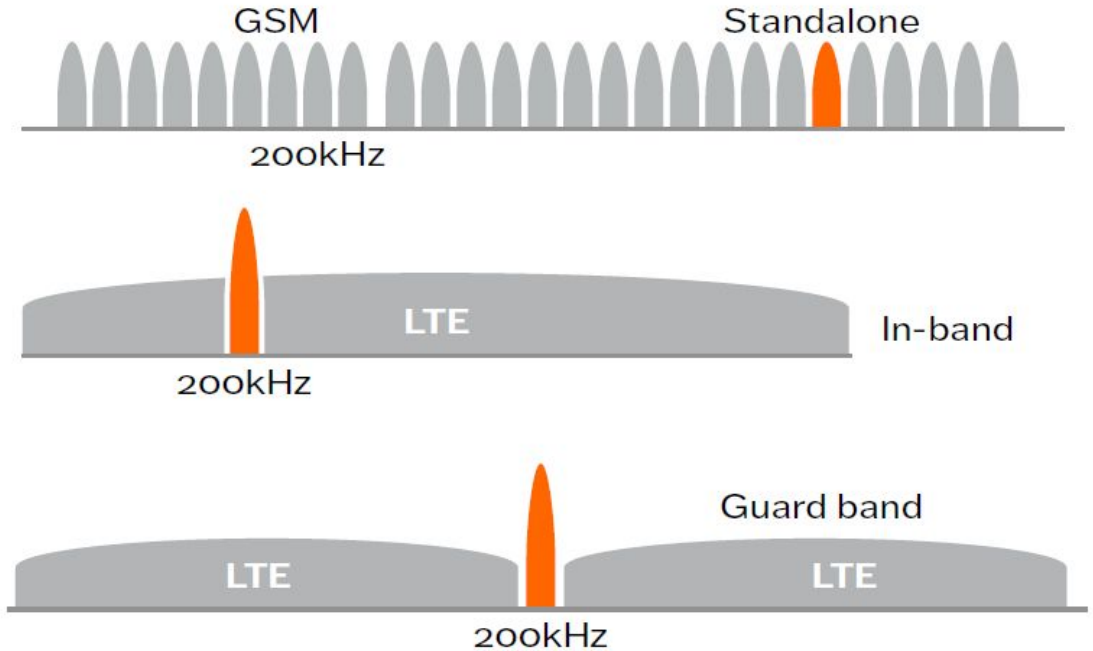
-  **Smart territories & industry**
 - Smart metering
 - Vending machine management
 - Industrial M2M
 - Critical assets tracking
-  **Automotive & logistics**
 - Fleet management
 - Onboard telemetry
-  **Smart home**
 - Remote control
 - Security (incl. video)
-  **Personal IoT**
 - Remote trackers
 - Wearables

NB-IoT

- Started in 2014 by a first 3GPP study
- Initial Specifications
 - Low device cost (<€5 per module)
 - Extended coverage (better than GSM/GPRS)
 - Large Capacity (> 40 devices per household, up to 100.000 devices per cell)
 - Long battery life (> 10 years, 1 packet a day, 200 bytes)
 - Moderate latency (< 10 seconds)
- part of LTE (4G) standards
- Mainly UDP

NB-IoT

- using existing licensed spectrum
- 200 kHz bandwidth
- 1 x NRB in LTE Band (180 kHz)



LTE Band	Uplink	Downlink
1	1920 - 1980	2110 - 2170
2	1850 - 1910	1930 - 1990
3	1710 - 1785	1805 - 1880
5	824 - 849	869 - 894
8	880 - 915	925 - 960
12	699 - 716	729 - 746
13	777 - 787	746 - 756
17	704 - 716	734 - 746
18	815 - 830	860 - 875
19	830 - 845	875 - 890
20	832 - 862	791 - 821
26	814 - 849	859 - 894
28	703 - 748	758 - 803
66	1710 - 1780	2110 - 2200

LTE-M

LTE-M operates on a 1.4 MHz carrier or 6 PRB.

The IoT device will always listen to the center 6 PRB for control information like any normal device. When the device is scheduled for IoT traffic, it will be allocated a number of PRBs (up to 6) at any consecutive location within the spectrum of operation. This means that the device will be allocated a 1.4 MHz carrier within a, for example, 20 MHz carrier.

The dedicated control and data is multiplexed in the frequency domain ignoring the legacy control information. This enables LTE IoT devices to be scheduled within any legacy LTE system and share the carrier capacity, antenna, radio and hardware at the site.

Standardized



Trials

Release 13

LTE-M

375 kbps

Cat-M1

NB-IoT

65 kbps

Cat-NB1

Release 14

LTE-M

2.5Mbps

Cat-M2

NB-IoT

150kbps

Cat-NB2

2015

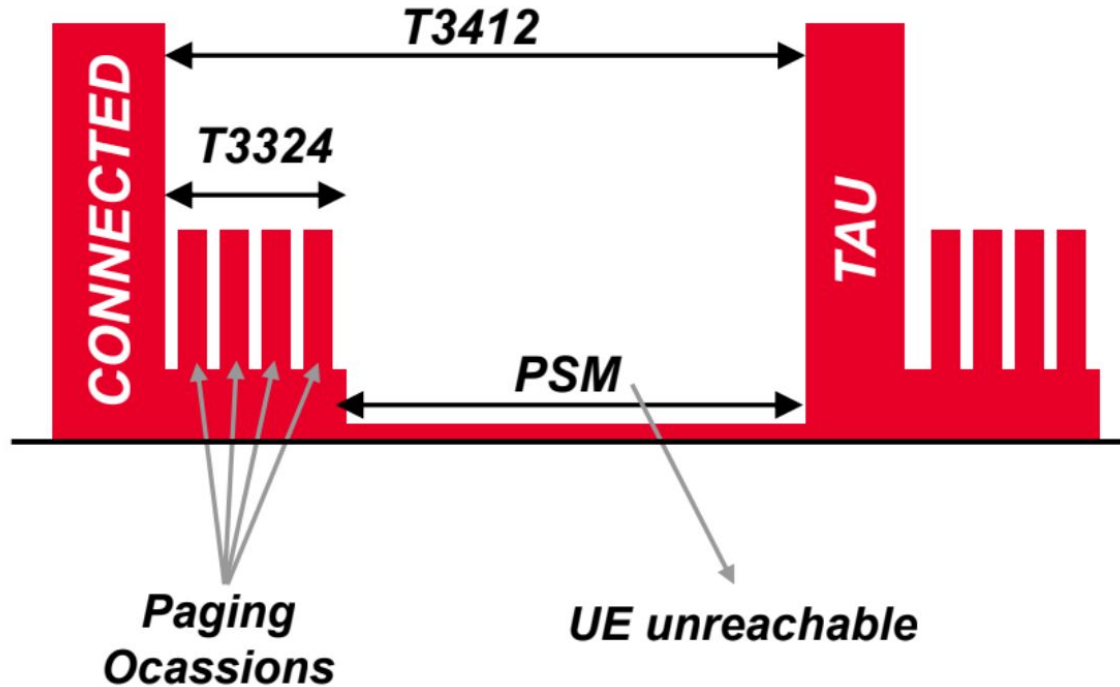
2016

2017

2018

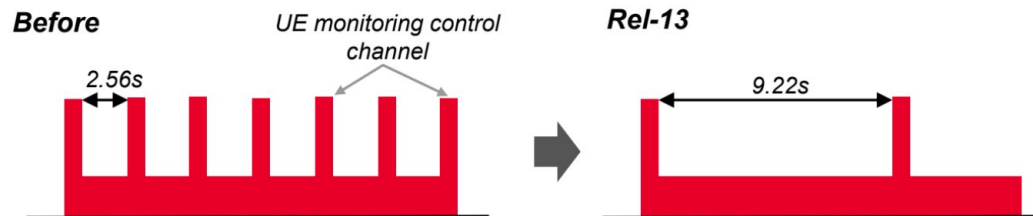
2019

NB-IoT & LTE-M Power



eDRX

CONNECTED eDRX



- DRX cycles extended from 2.56 seconds:
 - To 9.22 seconds in NB-IoT

IDLE eDRX



- New Paging Time Window which allows longer paging cycles:
 - 3 hours in NB-IoT

SODAQArc Main Current

Power switches:

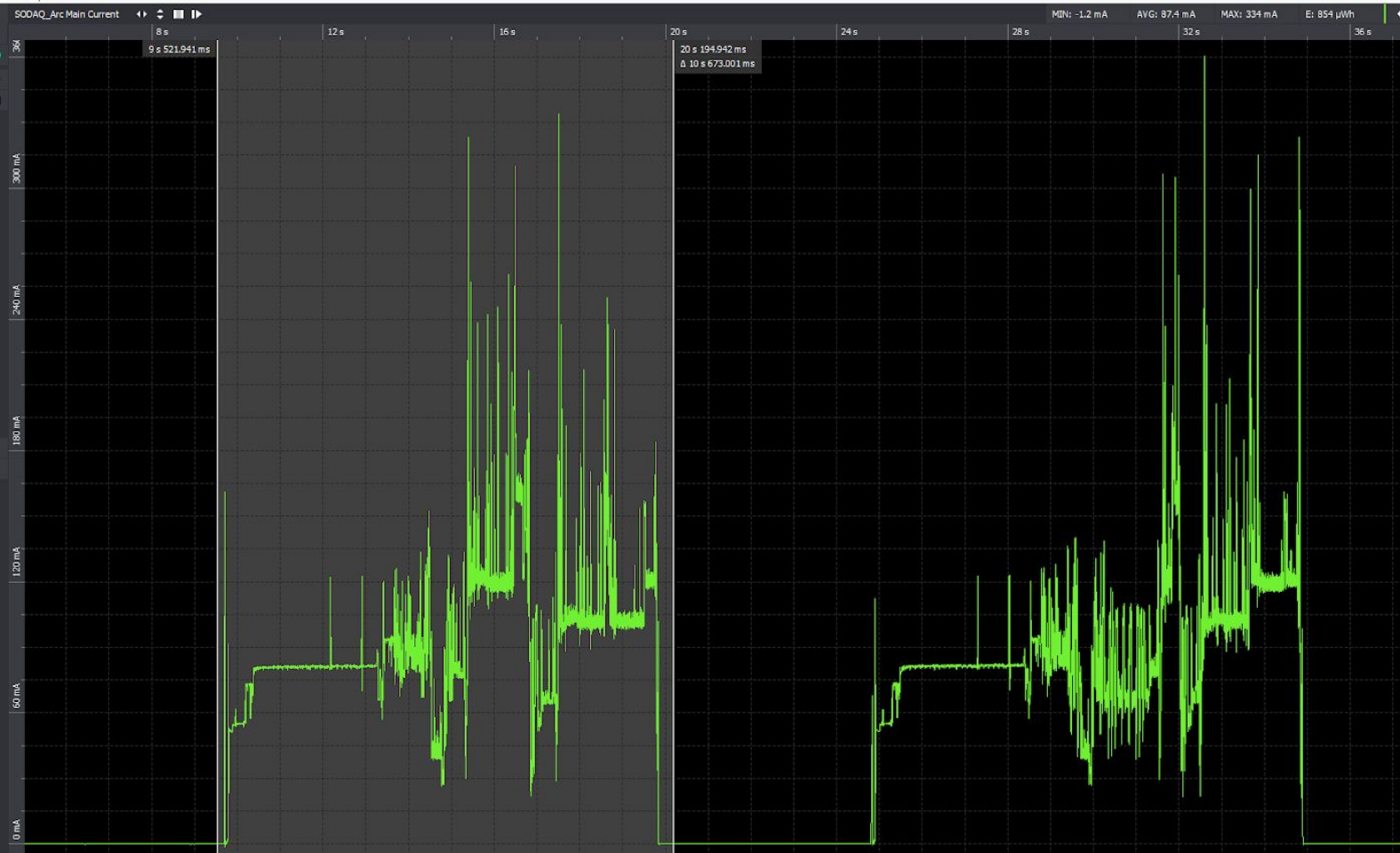
SODAQArc

Recordings

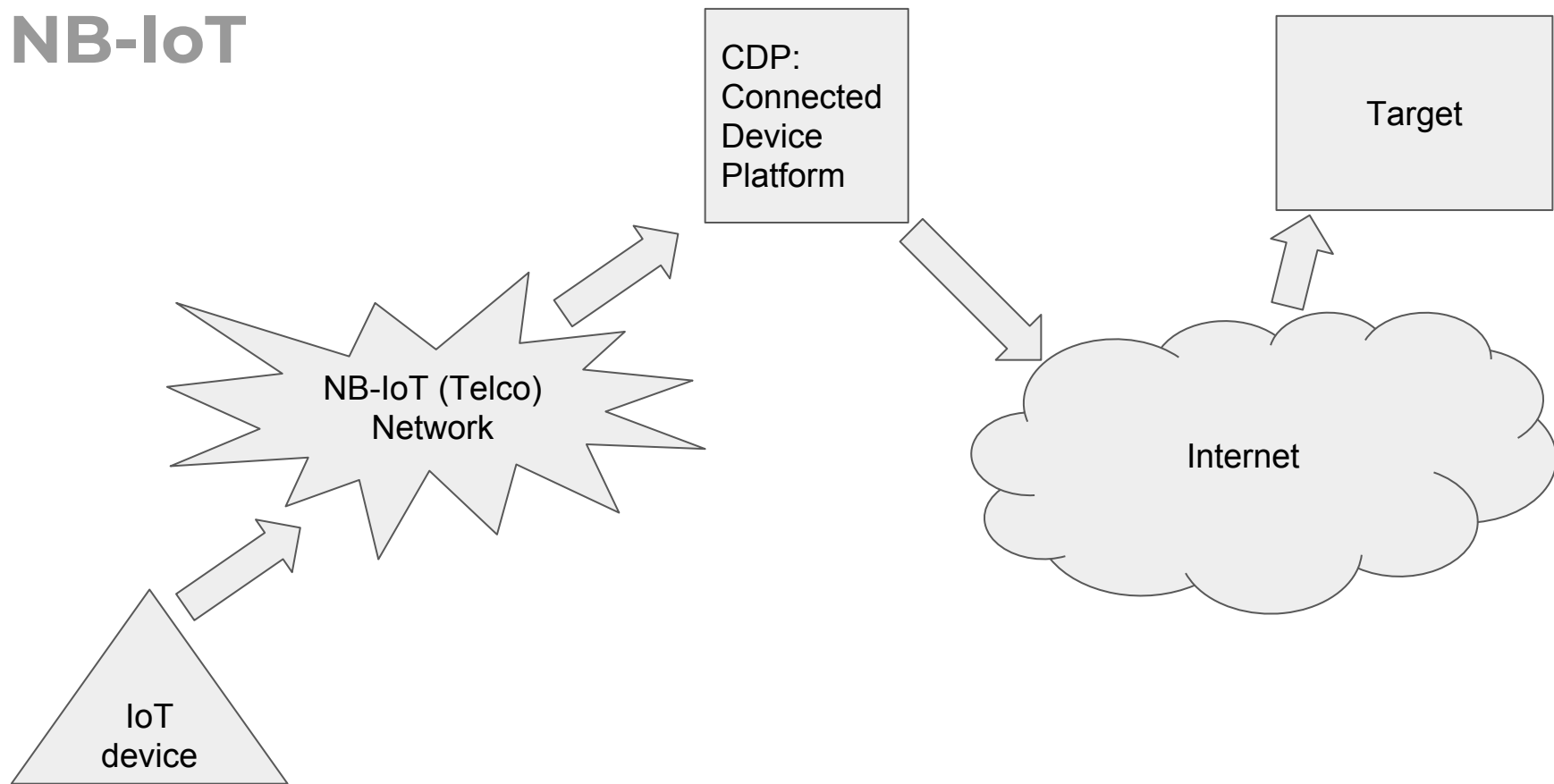
02/03 15:14:00

Visualizations

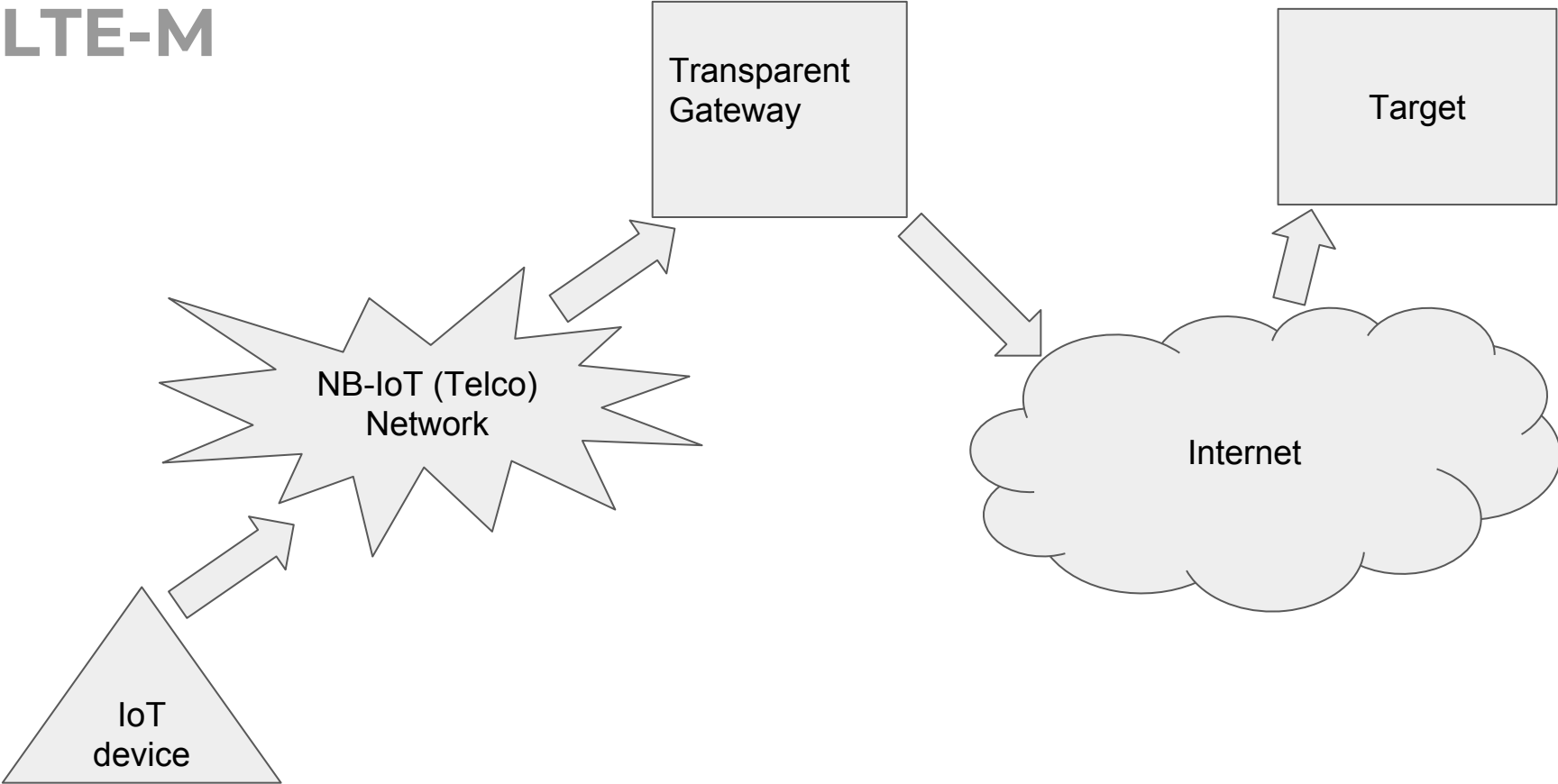
SODAQArc Main Current



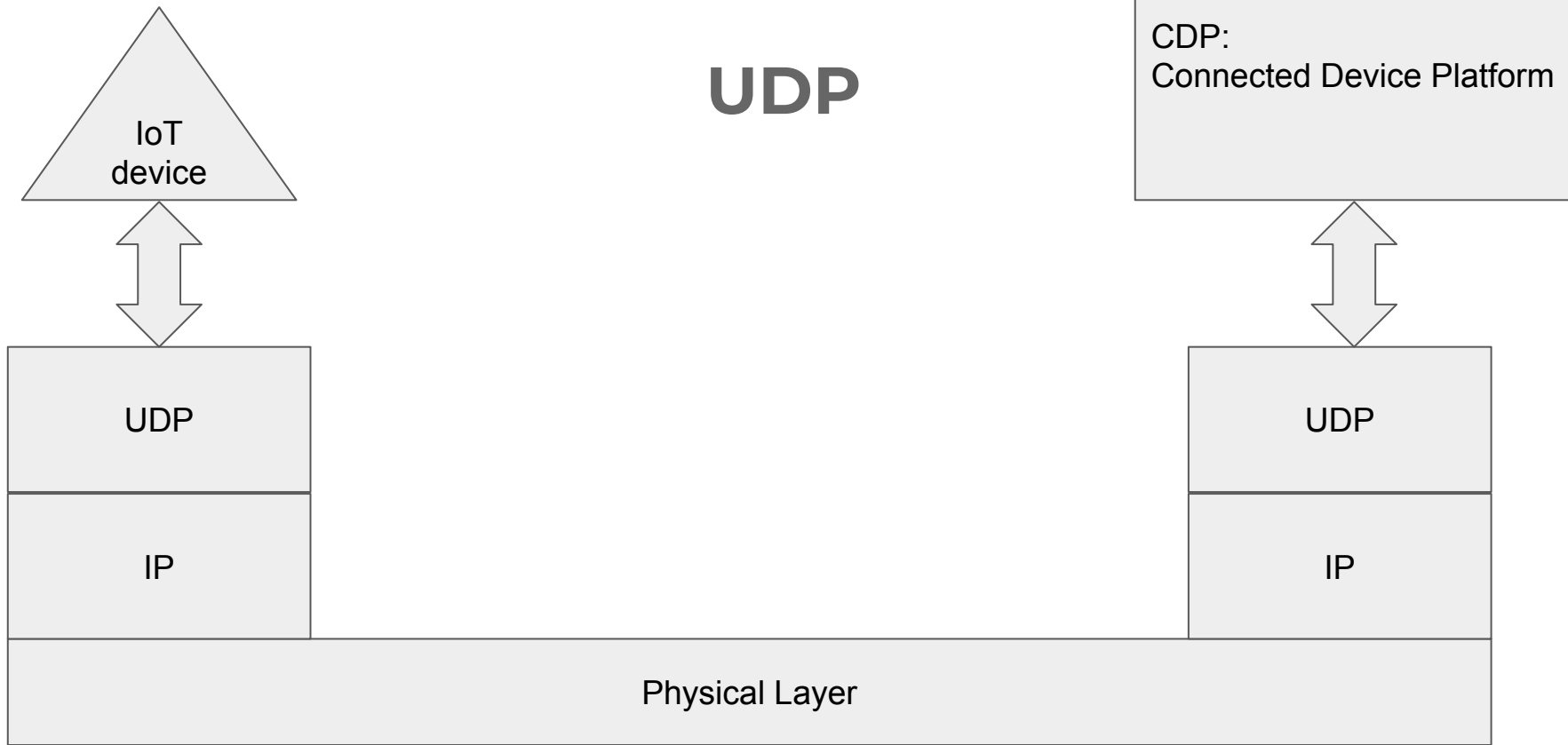
NB-IoT



LTE-M



UDP



SODAQ Sara

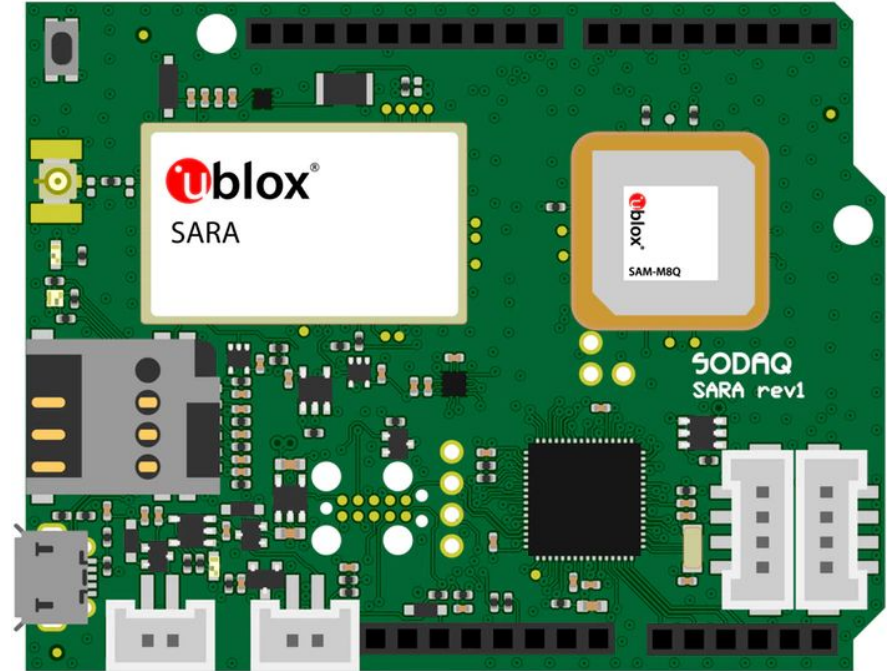
Arduino Compatible Board

32 bit microcontroller (SAMD21)

uBlox LTE-M Module

Standard GPS and Accelerometer
on board

Battery (and solar) powered



AT Commands

The Hayes command set is a specific command language originally developed by Dennis Hayes for the Hayes Smartmodem 300 baud modem in 1981.

https://www.u-blox.com/sites/default/files/SARA-R4_ATCommandsManual_%28UBX-17003787%29.pdf

AT Commands

ATE0

Switch echo off

AT Commands

AT+URAT=7

Select LTE-M

AT+URAT=8

Select NB-IoT

AT+URAT?

Choose the radio technology

AT Commands

AT+CFUN=0

switches off radio

AT+CGDCONT=1,"IP","internet.m2m"

choose APN

AT+CGDCONT?

AT+CFUN=1

switches on radio

AT Commands

AT+CFUN=1

Radio ON

AT+COPS=1,2,"20408"

Forces an attempt to select and register with the
network operator

AT+CSQ

Check signal quality (99,99 is no signal!)

AT+CREG=2

Set verbosity level

AT+CREG?

Check attach status

AT+CGPADDR

Check IP address assigned

AT Commands

AT+USOCR=17

Create UDP socket

AT+UDCONF=1,0

Set text mode (default)

AT+USOST=0,"37.97.216.22",3001,4,"Data"

Send text over socket

AT+UDCONF=1,1

Set HEX mode

AT+USOST=0,"37.97.216.22",3001,4,"44617461"

Send HEX over socket

AT+USOCL=0

Close socket

Hands on session:

- Install Arduino IDE
- Connect Arduino Serial terminal
- Load Ite-m commands sketch

For more information:

Files: <https://goo.gl/QRCW55>

git: https://github.com/janvl1234/Sodaq_NBloT_examples

<http://support.sodaq.com>

<http://forum.sodaq.com>