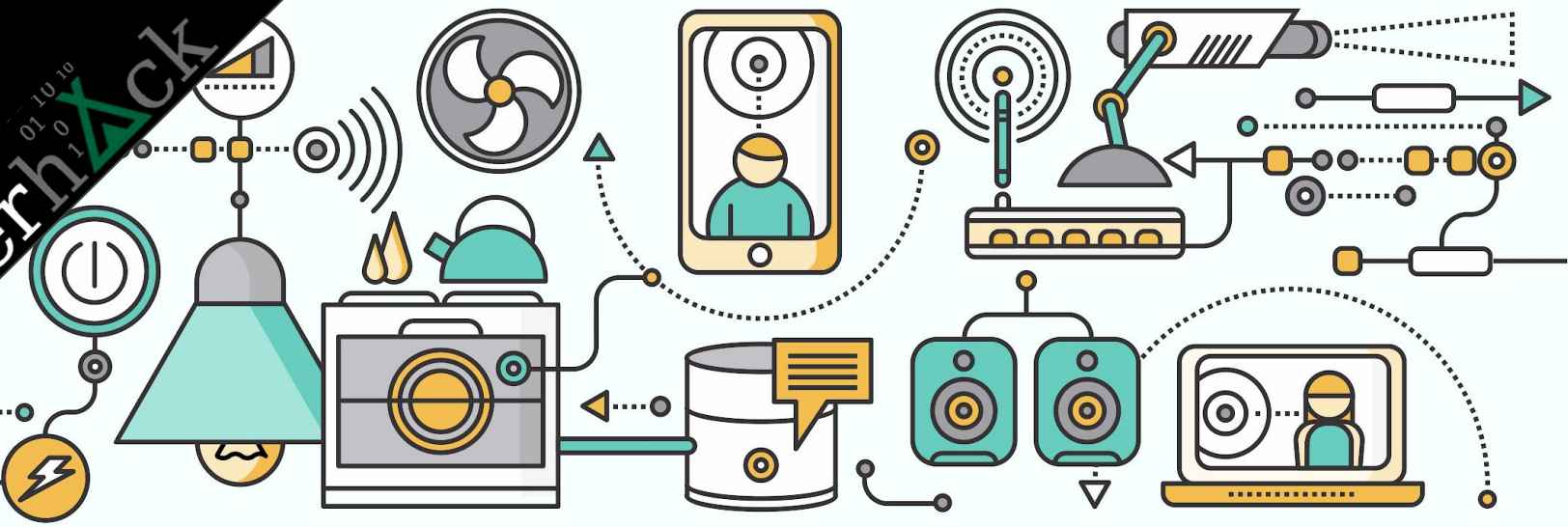


Sommerhack



LoRaWAN i Aarhus Kommune

nye sensorløsninger tilden smarte by

Intro

— — —



Carsten Michael Kaa

Projektleder - ITK Lab

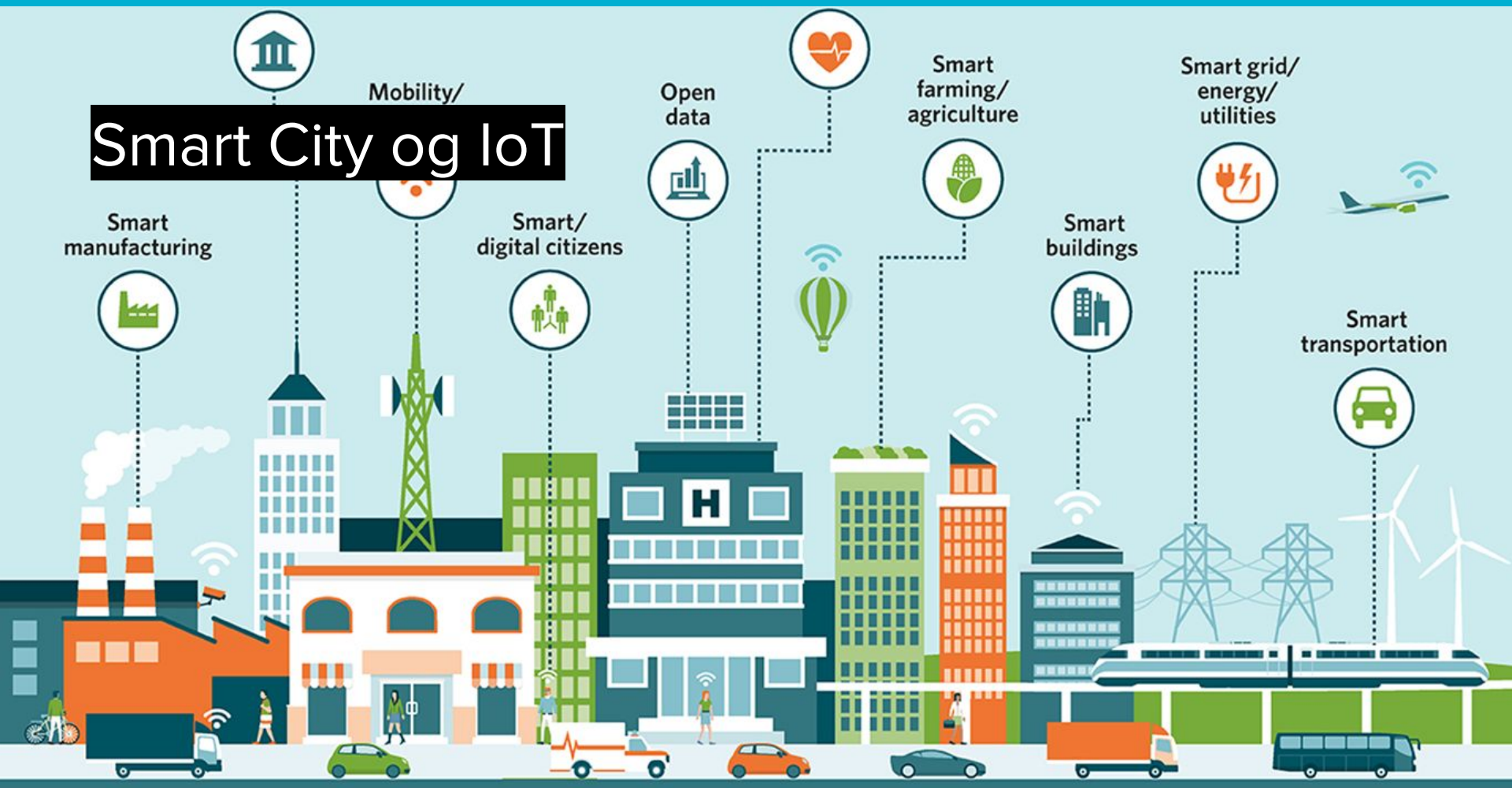
M +45 4185 6526

E cmkaa@aarhus.dk

ITK [Innovation - Teknologi - Kreativitet]
Kultur & Borgerservice
Aarhus Kommune



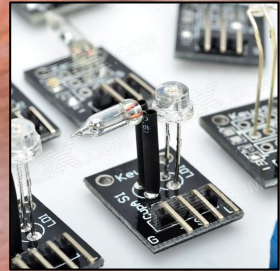
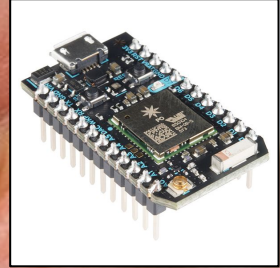
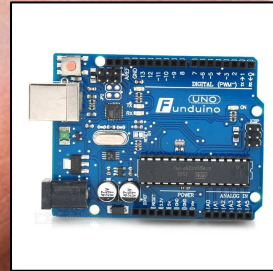
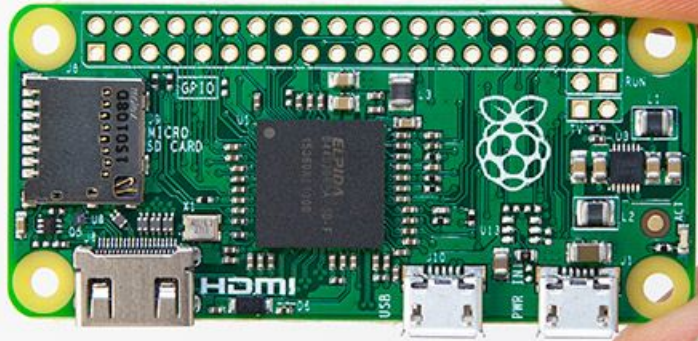
Smart City og IoT



Nye muligheder - nyt mindset



Lav pris på elektronik





Nye netværksteknologier med lang rækkevidde



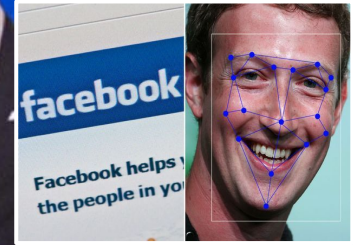
Batterilevetid 10+ år

Energy Harvesting vha. induktion, varme, bevægelser, lys ...

**Elektronik og datatransmission
med ultralavt strømforbrug**

Adgang til billig og skalérbar regnekraft
og datalagring i skyen - *pay as you go*

Lærende computersystemer der kan genkende mønstre og forstå verden



Datalagring er gratis

Computerkraft er gratis

ALT ER MULIGT

Elektronikken bruger ikke strøm

Vi kan selv bygge prototyper

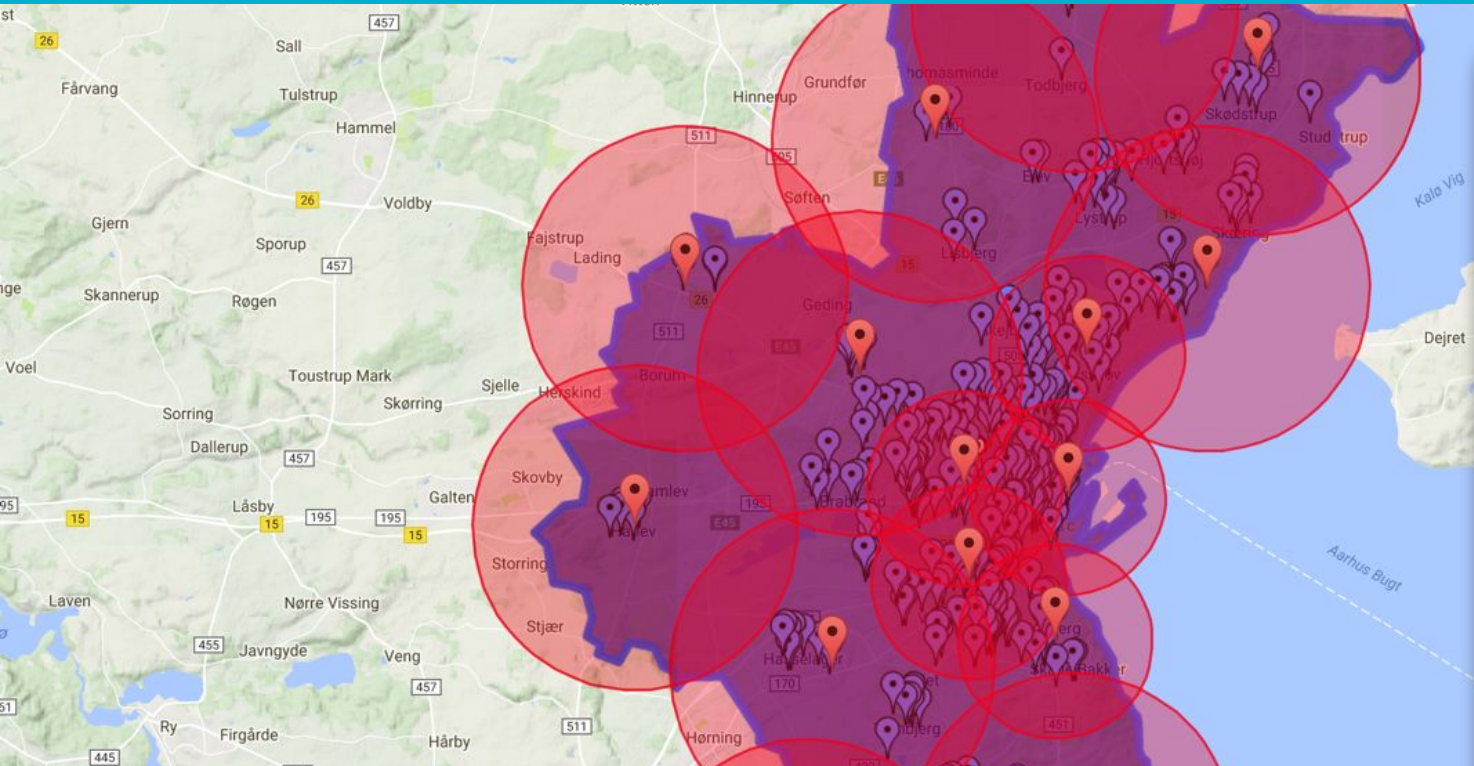
Netværksforbindelsen er gratis

Computeren forstår verden





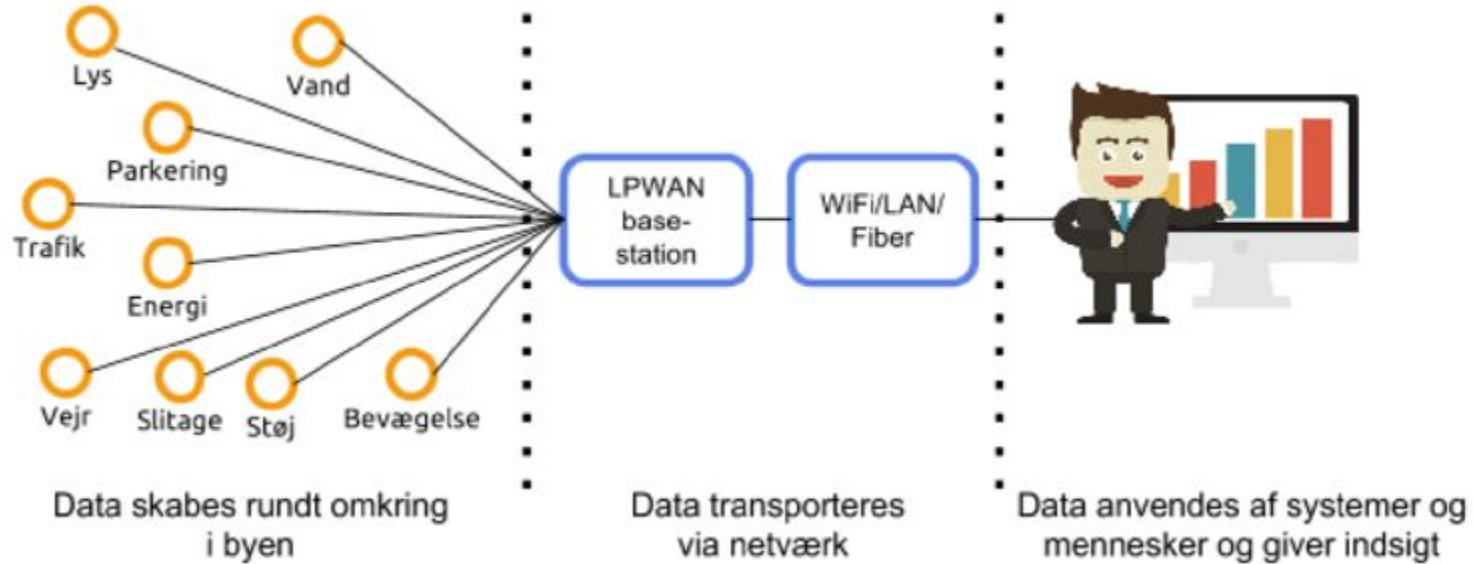
LoRaWAN i Aarhus Kommune



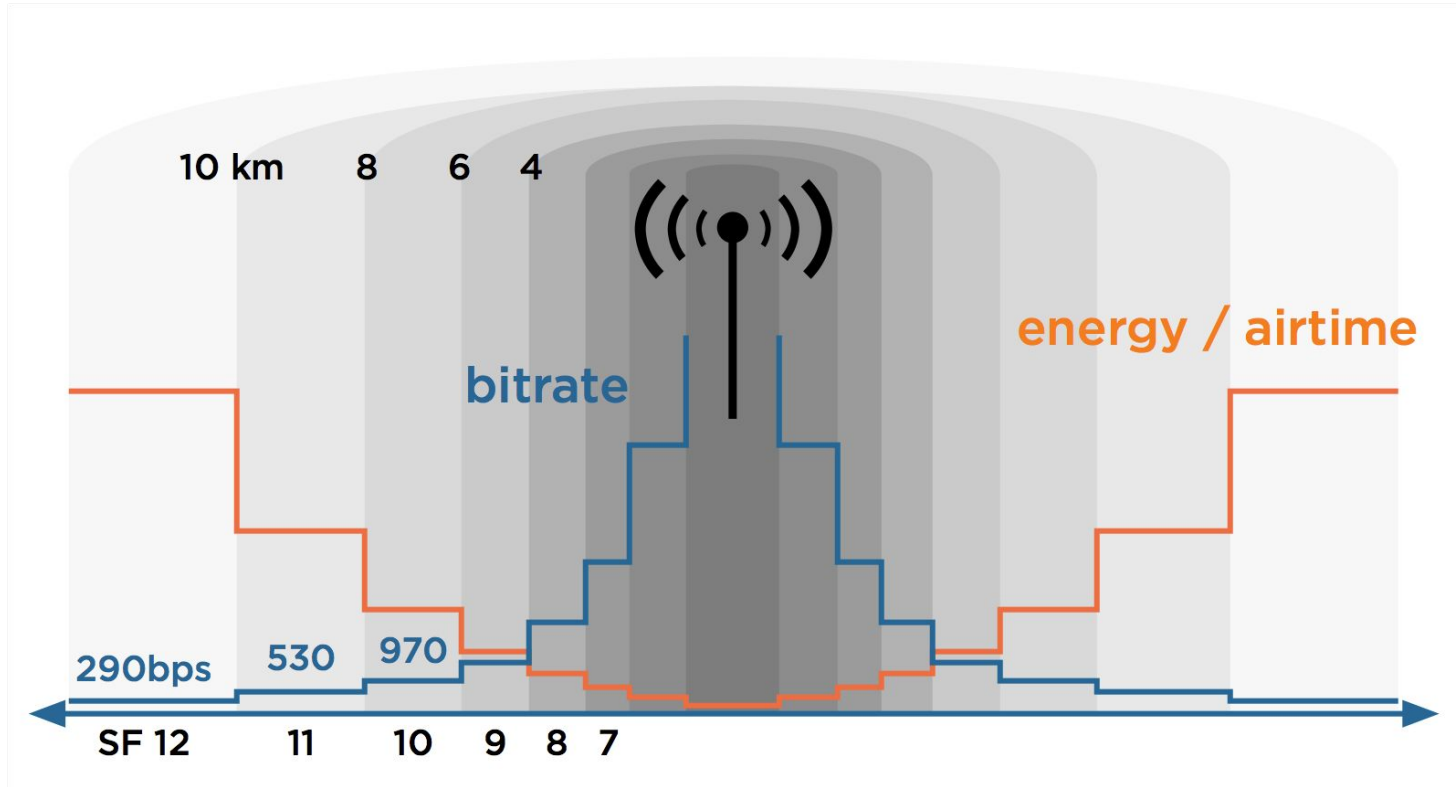
Mission: At dække hele kommunen med LoRaWAN



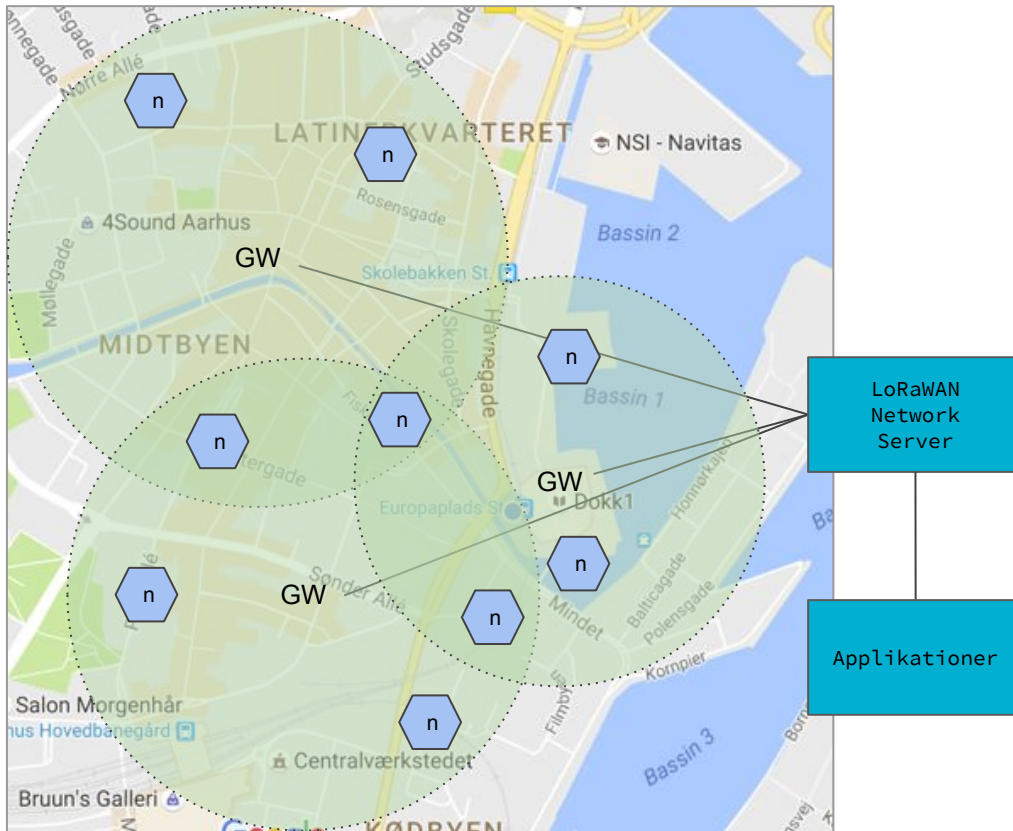
LoRaWAN - Flow



LoRaWAN - Rækkevidde og lavt strømforbrug

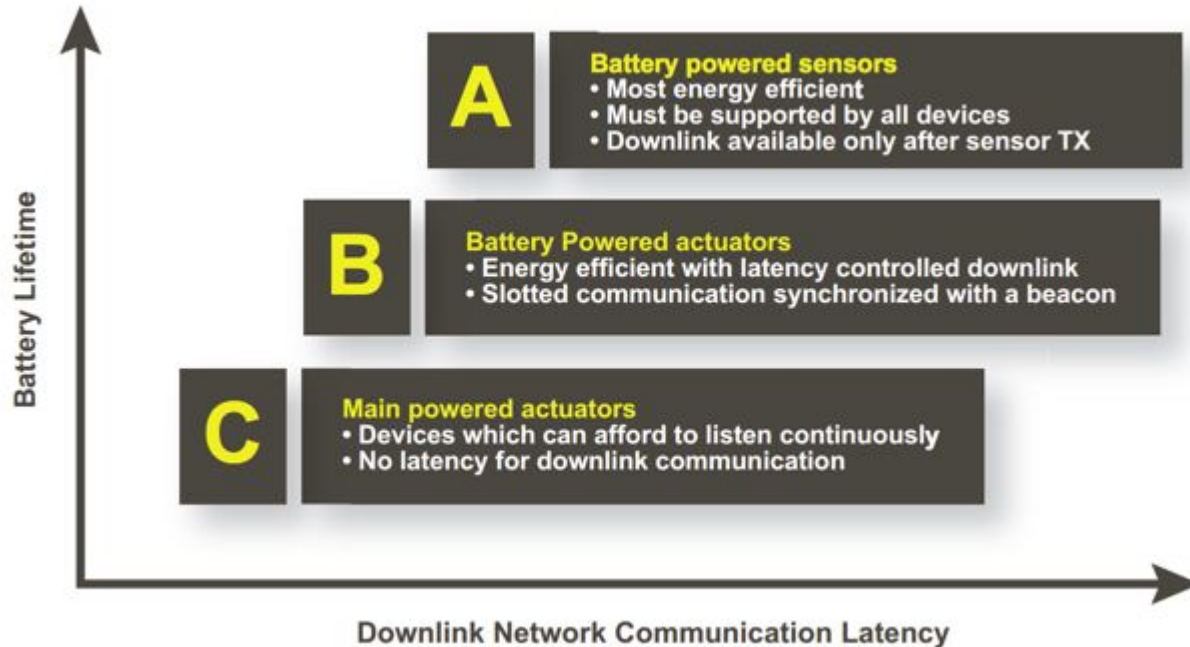


LoRaWAN - sådan virker det



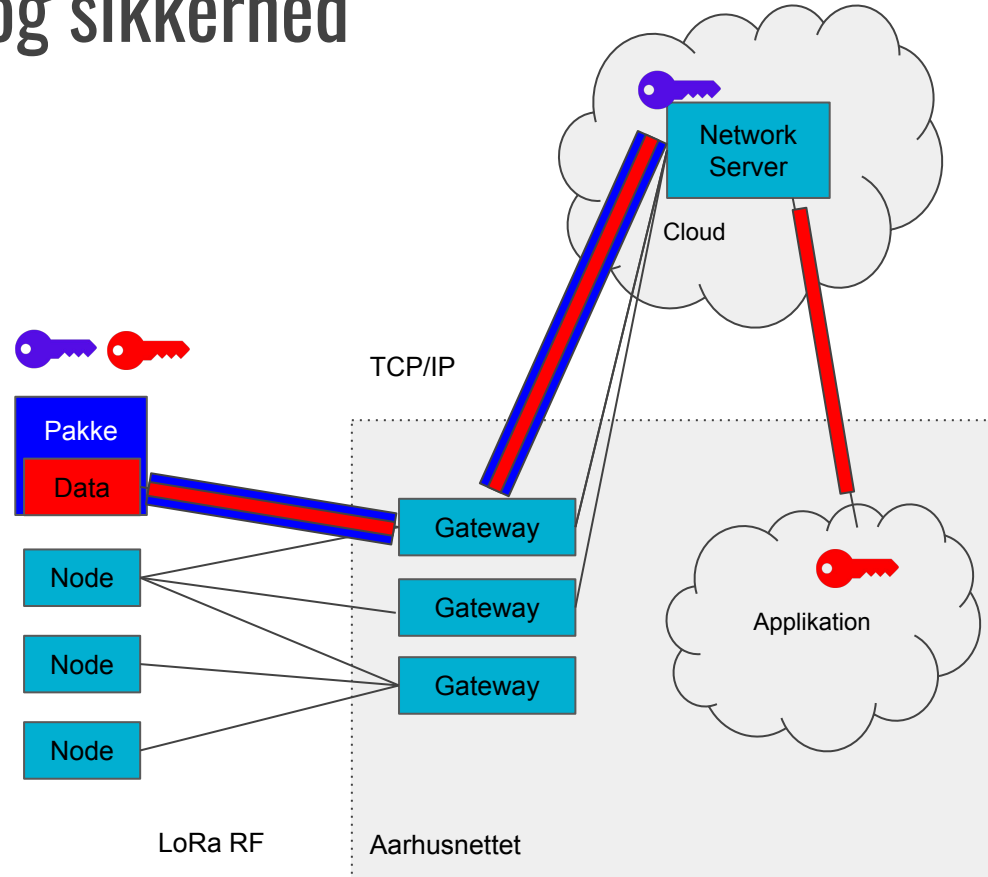
- Topologi: Star-of-stars med overlap
- Noder sender “ud i det blå”, ikke forbundet til specifik gateway (GW)
- GW “har store ører”, gode til at skelne mellem støj og besked
- Flere GW kan modtage samme besked, intelligens placeret i Network Server der “deduplikerer” pakker fra noder
- GW optimerer noders sendeparametre (ADR). Tæt på GW = mindre energi og kortere sendetid.
- Duty Cycle begrænsninger 1% (36s/t)
- Positionering vha. triangulering og uden handover mellem GWs. Præcision?

LoRaWAN - Class A, B, C



LoRaWAN - Arkitektur og sikkerhed

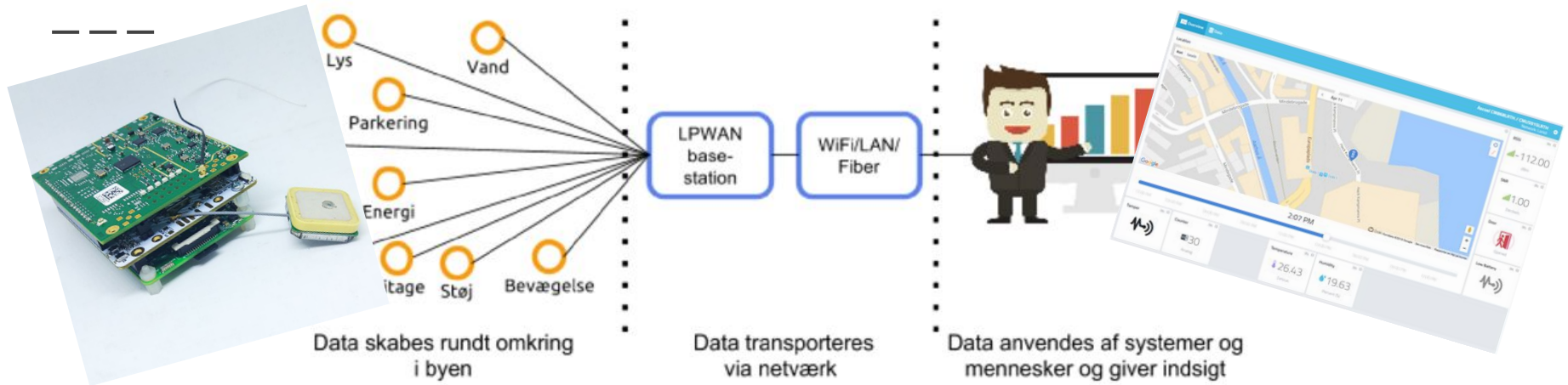
- Krypteret med nøgler (AES-128)
- Data dekrypteres først i Applikation
- 2 join metoder: OTAA og ABP





Sensorer og data

LoRaWAN - Opgaver



- Måle
- Bygge datapakke
- Sende/Opsaml

- Kryptere
- Optimere
- Transportere

- Modtage besked
- Fortolke datapakke
- Gemme data
- Behandle/berige data
- Dele data
- Visualisere data

LoRaWAN - Besked formater

- “RX”, “GW” og “TXD”
- Data = Data payload

```
[{"cmd":"gw","seqno":347,"EUI":"0018B20000001463","ts":1522998298550,"fcnt":16,"port":1,"freq":868300000,"toa":1646,"dr":"SF12BW125 4/5","ack":false,"gws":{"rssi":-111,"snr":-6,"ts":1522998298550,"time":"2018-04-06T07:04:58.388055104Z","rsig":{"ant":0,"chan":6,"rssi":-111,"lsnr":-6,"etime":"eCoiiie5CDPhvKnYHDY4BIQ==","rssi":-118,"rssid":5,"ftime":-1,"foff":94,"ftd":431,"rfsb":96,"rs2s1":120}},"gweui":"7076FFFFFF010B88"},{"rssi":-115,"snr":-3,"ts":1522998298554,"time":"2018-04-06T07:04:58.388060961Z","rsig":{"ant":0,"chan":6,"rssi":-115,"lsnr":-3}},"gweui":"7076FFFFFF010B32"},"bat":200,"data":"bf18560951500101580037130f0fc76d03"}]
```

4. DECODING THE PAYLOAD

The size of the Field Test Device's payload can vary depending on the information transmitted. The first byte will enable you to identify the presence of information contained in the payload. Information will always be shown in the order indicated in the following table.

Example of a payload received: BF1B45159690005534502720200FC95207
This example will be used in order to explain how the payload is decoded.

Order	1	2	3	4	5	6	7	8	9	10
Number of bytes	1	1	4	4	1	1	1	2	1	1
Description	Statut	Temperature	GPS Latitude	GPS Longitude	GPS Qualité	UL Counter	DL Counter	Battery level	RSSI	SNR
Example	BF	1B	45 15 96 90	00 55 34 50	27	20	20	0F C9	52	07

LoRaWAN - Databehandling

- Eksempler fra Loriot netværksserveren





Hvad skal vi bruge LoRaWAN til?

Use cases



Use cases



Use cases

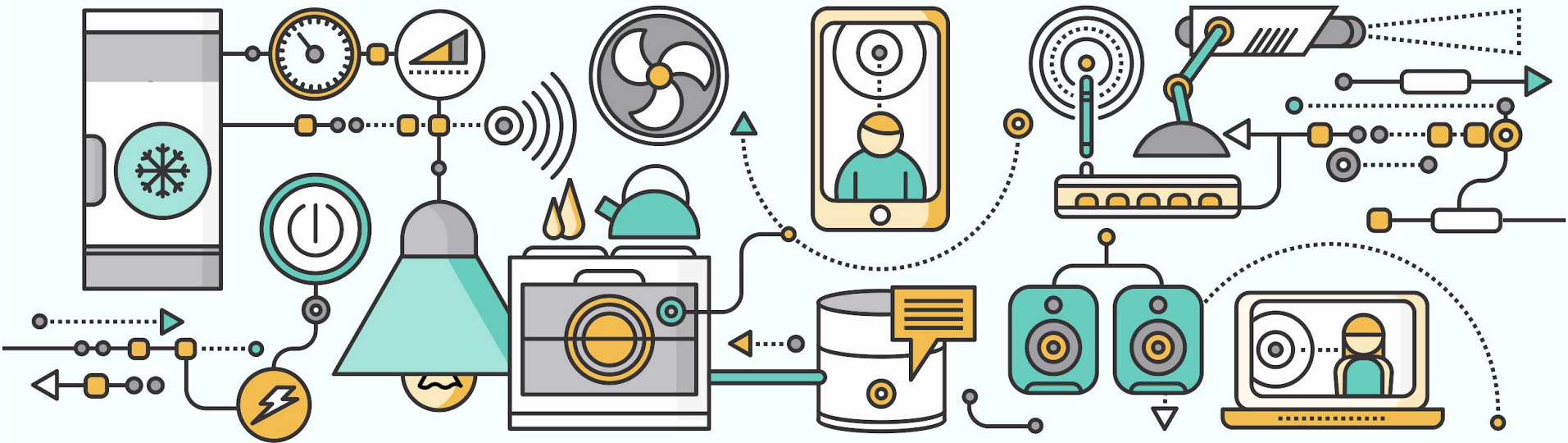


Use cases



Kæmpe potentiale...





Hvordan kan I bidrage?

[COMMUNITIES](#)[LABS](#)[LEARN](#)[SUPPORT](#)[FORUM](#)[SHOP](#)[SIGN UP](#)[LOGIN](#)

Join our first global LoRaWAN developer conference

[Get Tickets](#)

The Things Network

[JOIN THIS COMMUNITY](#)

The Things Network

Start a community



Aalborg

3 contributors

3 gateways



Aarhus ✓

32 contributors

6 gateways



Copenhagen ✓

49 contributors

44 gateways



Esbjerg

5 contributors

0 gateways



Silkeborg

5 contributors

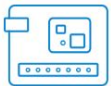
2 gateways

Documentation



Learn about LoRaWAN: the secure messaging protocol used by Th

Devices



Connect devices to The Things Network.

Gateways



Extend The Things Network by installing a gateway.

Network



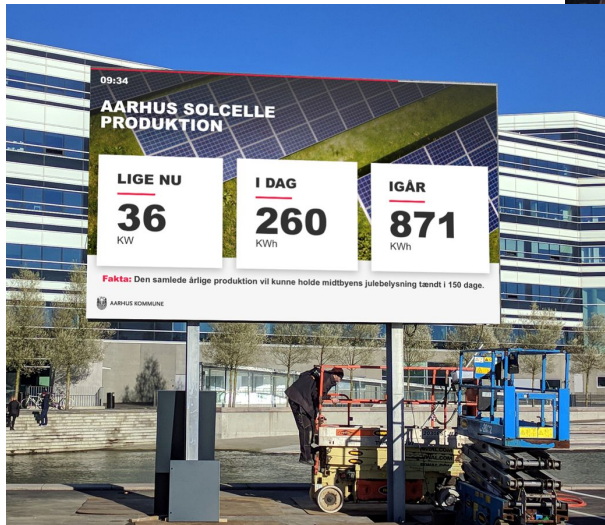
Manage your applications and devices.

Applications



Build applications on The Things Network.

City Lab i Aarhus



Projekt: IoTcrawler

Thingful.net
- Example of IoT search engine

The screenshot displays the Thingful.net web interface. At the top left is the 'thingful' logo. Below it is a search bar with the placeholder text 'What data do you want?' and a location selector with the placeholder 'Where?'. The main area is a satellite map of Aarhus, Denmark, with several blue location markers scattered across the city. On the right side, a data panel is open for a specific device. The panel has a yellow header with the text 'Energy' and a 'Refresh' button. Below the header, the device name 'PCM6048 Solar Panel Battery Charger' is displayed in bold. Underneath, the word 'Shared' is shown in orange. The panel lists four data points: 'Battery Charge Current' with a value of 2.3, 'Battery Temperature' with a value of -19.1, 'Battery Voltage' with a value of 25.1, and 'Heat Sink Temperature' with a value of 34.7. At the bottom of the panel, it says 'Updated 10 months ago' and has a blue 'Watch' button.

Energy	
PCM6048 Solar Panel Battery Charger	
Shared	
Battery Charge Current	2.3
Battery Temperature	-19.1
Battery Voltage	25.1
Heat Sink Temperature	34.7
Updated 10 months ago	
Watch	

Projekt: IoTcrawler - Følgegruppe

- Netværk med Aarhus' lokale smart city netværk og international smart city netværk
- Få den nyeste viden om smart city udviklingen
- Invitation til særlige arrangementer
- Adgang til kontakter for mulige samarbejder

Følg med!

IoT CRAWLER



@iotcrawler



/iotcrawler.eu



/iotcrawler



www.iotcrawler.eu



mbm@aarhus.dk

Open Data

The screenshot shows the Open Data DK website. At the top right, there are links for "Log ind" and "Registrér". The main header features the "OPEN DATA DK" logo on the left and navigation links for "Datasæt", "Organisationer", "Grupper", and "Om" in the center. A search bar on the right contains the text "Søg" and a magnifying glass icon. Below the header, there are two main content areas. The left area has a white background with the heading "Open Data DK åbner Danmark op" and text explaining the platform and providing contact information. The right area has a red background with the heading "Search data", a search input field containing "f.eks. parkering", and a "Popular Tags" section with buttons for "Vejle", "aarhus kommune", "Kort", "Aarhus Kommune", "parkering", and "trafik".

OPEN DATA DK Datasæt Organisationer Grupper Om Søg

Open Data DK åbner Danmark op
Dette er Open Data DKs open data platform.
Der er ingen registrering før brug af vores data, men du må meget gerne fortælle os, hvis du laver noget fedt med dem. Skriv til (info@opendata.dk)
Du kan læse mere om Open Data DK på (<http://www.opendata.dk>)

Search data
f.eks. parkering

Popular Tags Vejle aarhus kommune Kort Aarhus Kommune parkering trafik

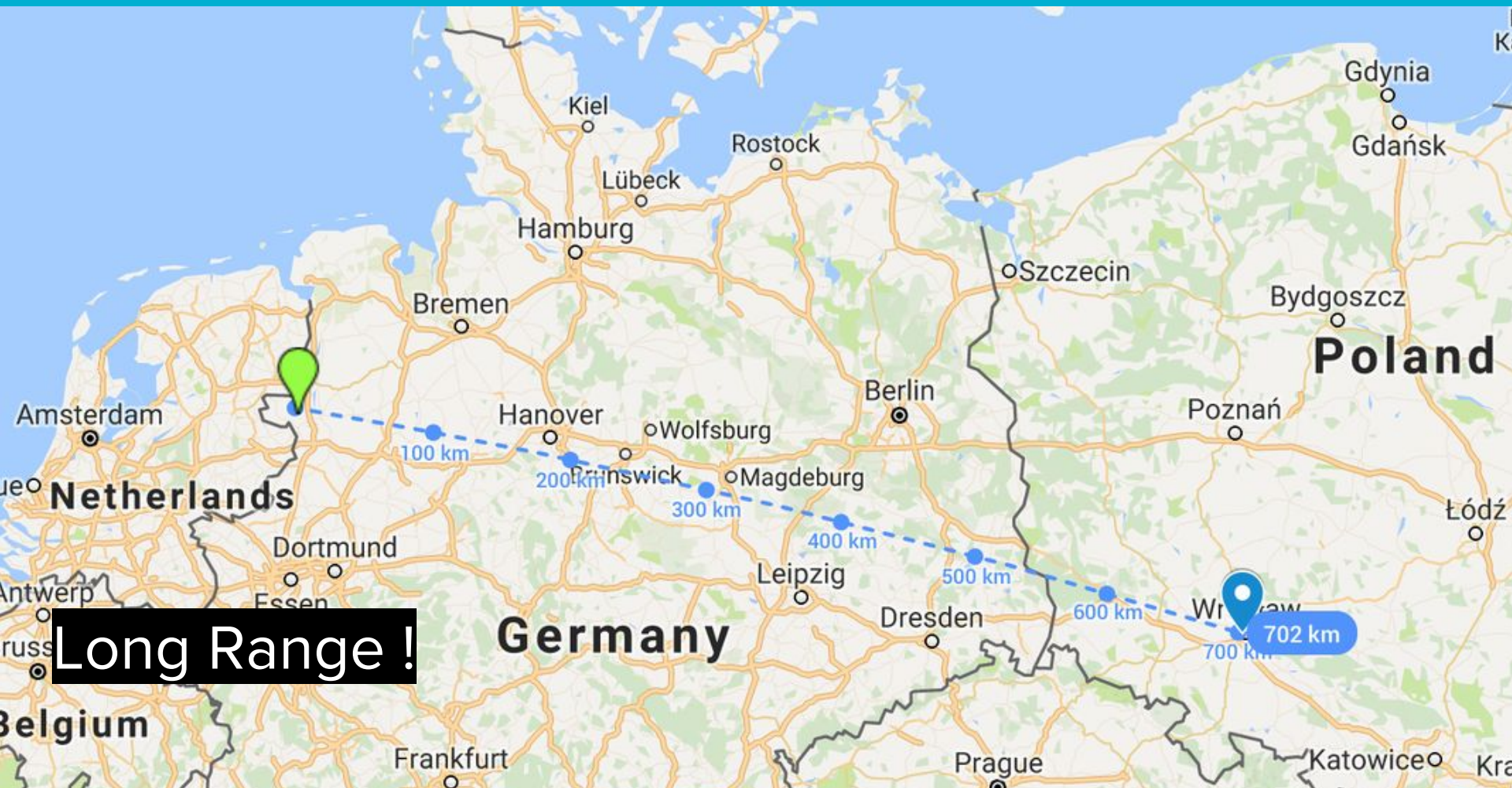
<https://portal.opendata.dk/>

LoRaWAN i Aarhus

Spørgsmål?

LoRaWAN i Aarhus

Hjælpe slides



Long Range!

Specs

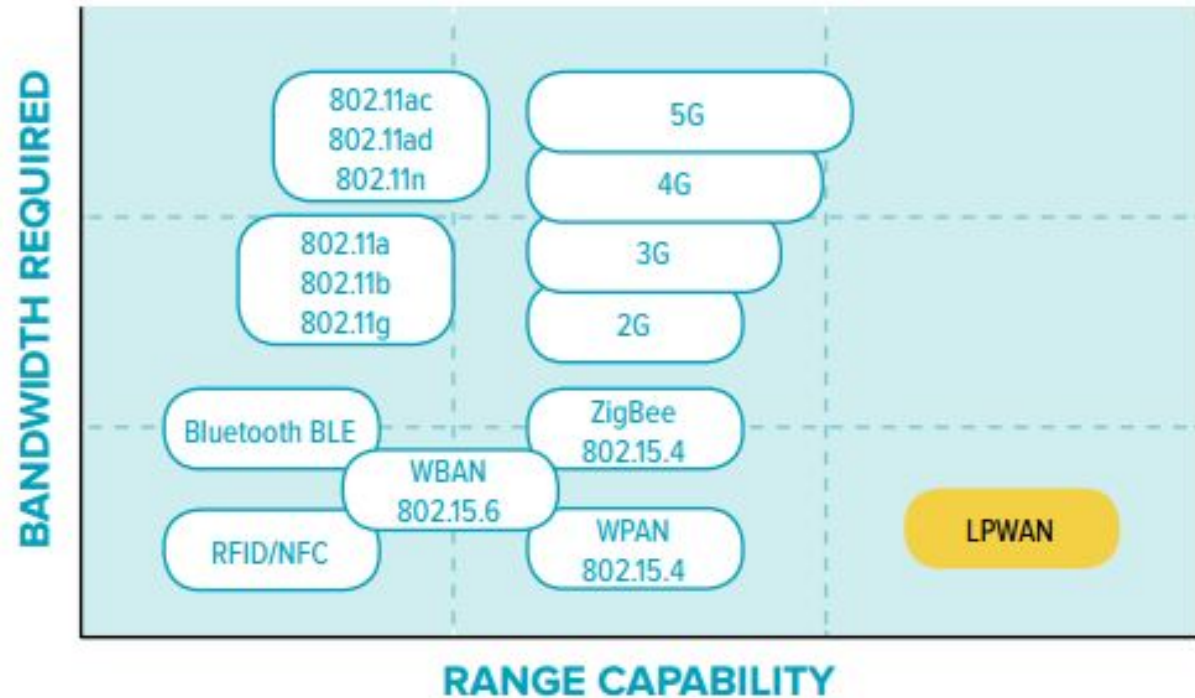
Længste distance:

SF=12 -> **Bit rate = 292 bps / Max. payload = 51 bytes**

Højeste Bit rate:

SF=7 -> **Bit rate = 10937 bps / Max. payload = 222 bytes**

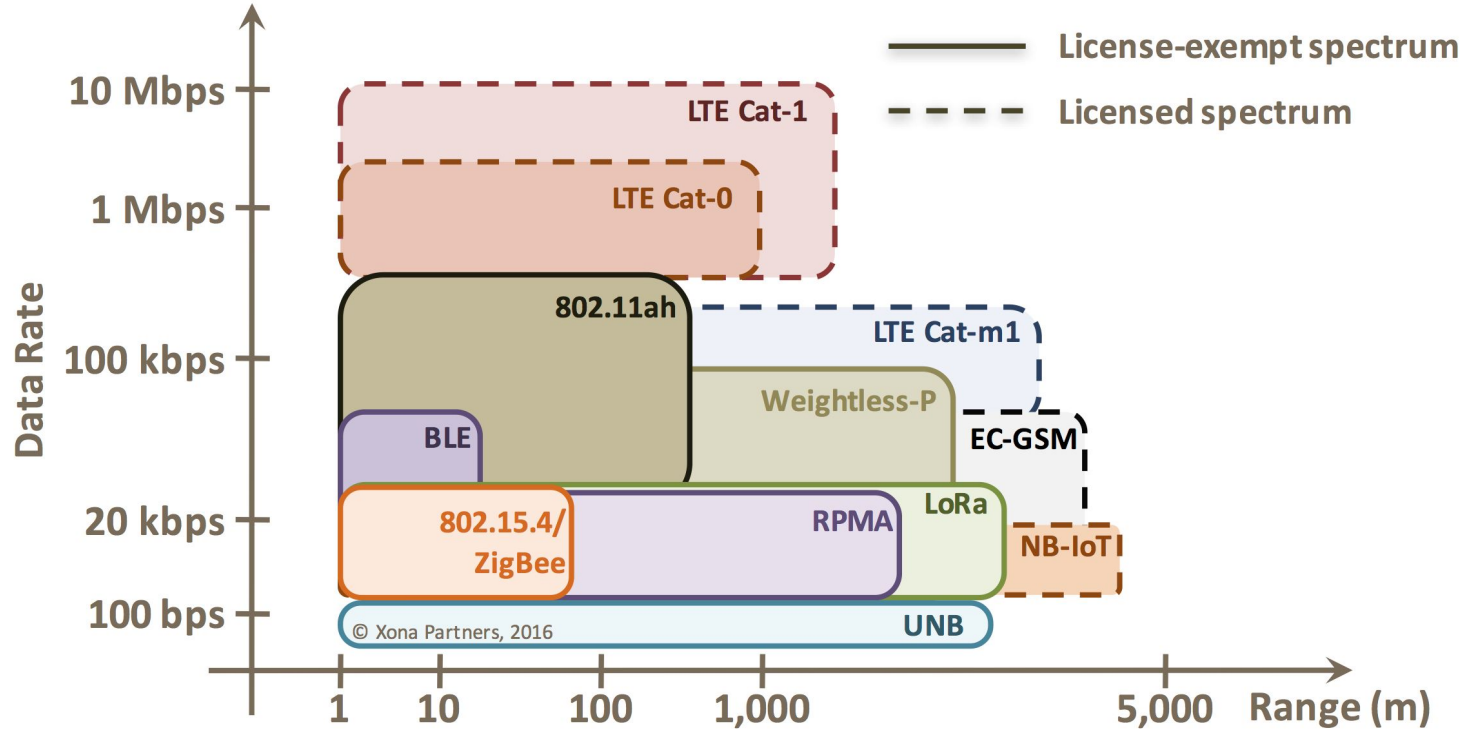
Sammenligning



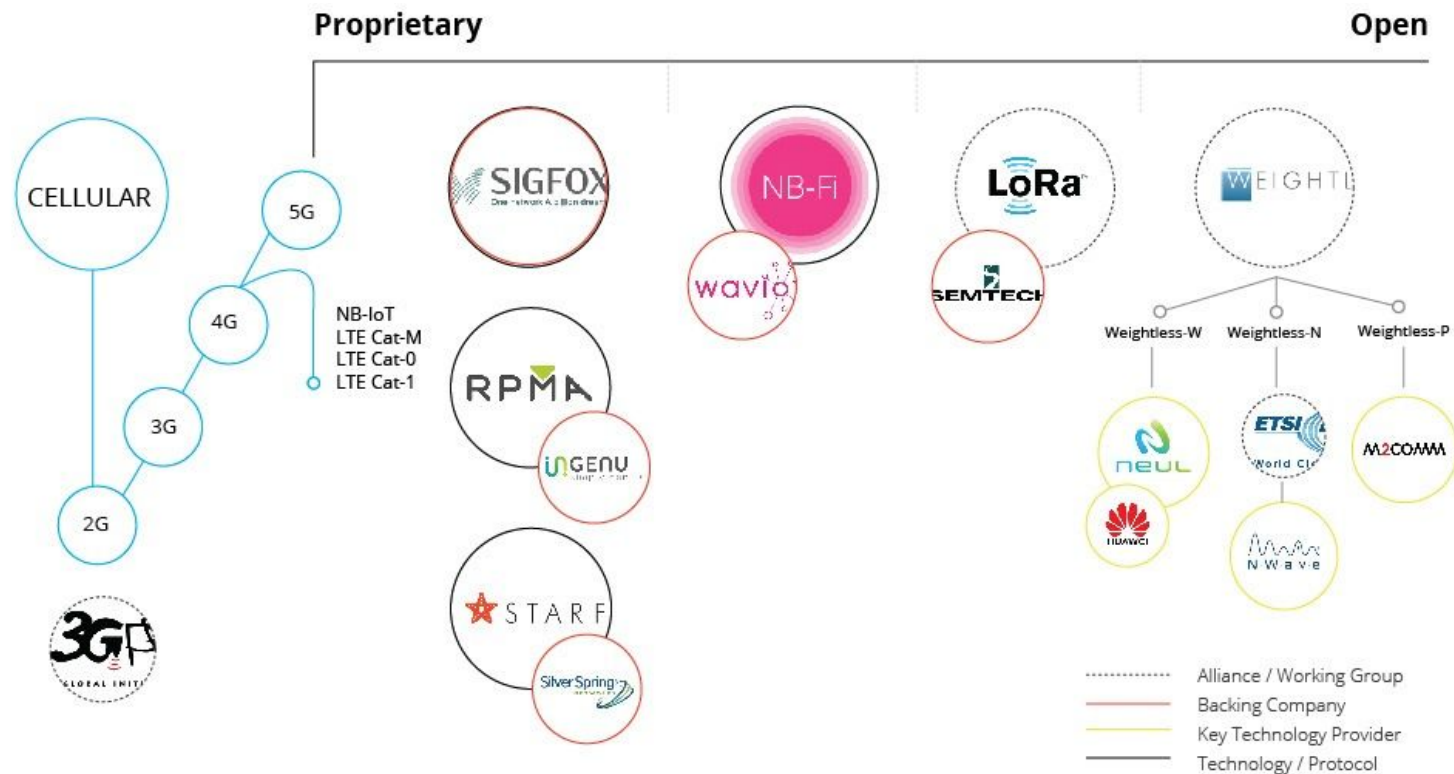
Sammenligning

Feature	LoRaWAN	Narrow-Band	LTE Cat-1 2016 (Rel12)	LTE Cat-M 2018 (Rel13)	NB-LTE 2019(Rel13+)
Modulation	SS Chirp	UNB / GFSK/BPSK	OFDMA	OFDMA	OFDMA
Rx bandwidth	500 - 125 KHz	100 Hz	20 MHz	20 - 1.4 MHz	200 KHz
Data Rate	290bps - 50Kbps	100 bit/sec 12 / 8 bytes Max	10 Mbit/sec	200kbps – 1Mbps	~20K bit/sec
Max. # Msgs/day	Unlimited	UL: 140 msgs/day	Unlimited	Unlimited	Unlimited
Max Output Power	20 dBm	20 dBm	23 - 46 dBm	23/30 dBm	20 dBm
Link Budget	154 dB	151 dB	130 dB+	146 dB	150 dB
Batery lifetime - 2000mAh	105 months	90 months		18 months	
Power Efficiency	Very High	Very High	Low	Medium	Med high
Interference immunity	Very high	Low	Medium	Medium	Low
Coexistence	Yes	No	Yes	Yes	No
Security	Yes	No	Yes	Yes	Yes
Mobility / localization	Yes	Limited mobility, No loc	Mobility	Mobility	Limited Mobility No Loc

Sammenligning



LPWAN marketet



Kerlink hardware

Features	iFemtocell	Station	iBTS compact	iBTS
ISM Bands	868/915 & 923	433/868/915 & 923	868/915 & 923	868/915 & 923
SPN: Small Private Network*	868/915 & 923	868/915 & 923		
Power supply	AC/DC	PoE 15W	PoE 30W	PoE 60W
Casing	IP31 or IP54 (with connectors)	IP67 incl. Mounting kit	IP67 incl. Mounting kit	IP66 incl. Mounting kit
Backhaul	WiFi & Ethernet	Ethernet & 3G	Ethernet & 3G/4G	Ethernet & 3G/4G
LoRa® TX Power	27dBm	27dBm	30dBm	30dBm
LoRa® channels	8	8	16	Up to 64
Geolocation			√	√
Real time radio scanning	√	√	√	√
Diversity			√	√
Capacity	>700 000 msg /day	>700 000 msg /day	1,4M msg /day	>Up to 5,6M msg/day
Use cases	Smart-Building & Indoor densification	Smart-Farming, Metering & Industry	Asset tracking, Densification, Deep indoor & Dense urban Smart cities	Asset tracking, Densification, Deep indoor & Dense urban, Smart cities