Communication Options for IoT

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Parameters

When considering communications options, parameters to be considered are:

Range
Multihop capabilities
Battery consumption
Security
Cost (device)
Cost (service)
Availability
Regulation

IoT specific case

IoT nodes can accept:

Low throughput, for many applications

Which ones don't?

Delays

Long Sleeping times

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

- AERONAUTICAL MOBILE
- AERONAUTICAL MOBILE SATELLITE
- AERONAUTICAL RADIONAVIGATION
- AMATEUR
- AMATEUR SATELLITE
- BROADCASTING
- BROADCASTING SATELLITE
- EARTH EXPLORATION SATELLITE
- FIXED
- FIXED SATELLITE
- INTER-SATELLITE
- LAND MOBILE
- LAND MOBILE SATELLITE
- MARITIME MOBILE
- MARITIME MOBILE SATELLITE
- MARITIME RADIONAVIGATION
- METEOROLOGICAL
- METEOROLOGICAL SATELLITE
- MOBILE
- MOBILE SATELLITE
- RADIO ASTRONOMY
- RADIODETERMINATION SATELLITE
- RADIOLOCATION
- RADIOLOCATION SATELLITE
- RADIONAVIGATION
- RADIONAVIGATION SATELLITE
- SPACE OPERATION
- SPACE RESEARCH
- STANDARD FREQUENCY AND TIME SIGNAL
- STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

ACTIVITY CODE

- FEDERAL EXCLUSIVE
- FEDERAL/NON-FEDERAL SHARED
- NON-FEDERAL EXCLUSIVE

ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

This chart is a graphic single-point-in-time portrayal of the Table of Frequency Allocations used by the FCC and NTIA. As such, it may not completely reflect all aspects, i.e. footnotes and recent changes made to the Table of Frequency Allocations. Therefore, for complete information, users should consult the Table to determine the current status of U.S. allocations.

U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management

JANUARY 2016

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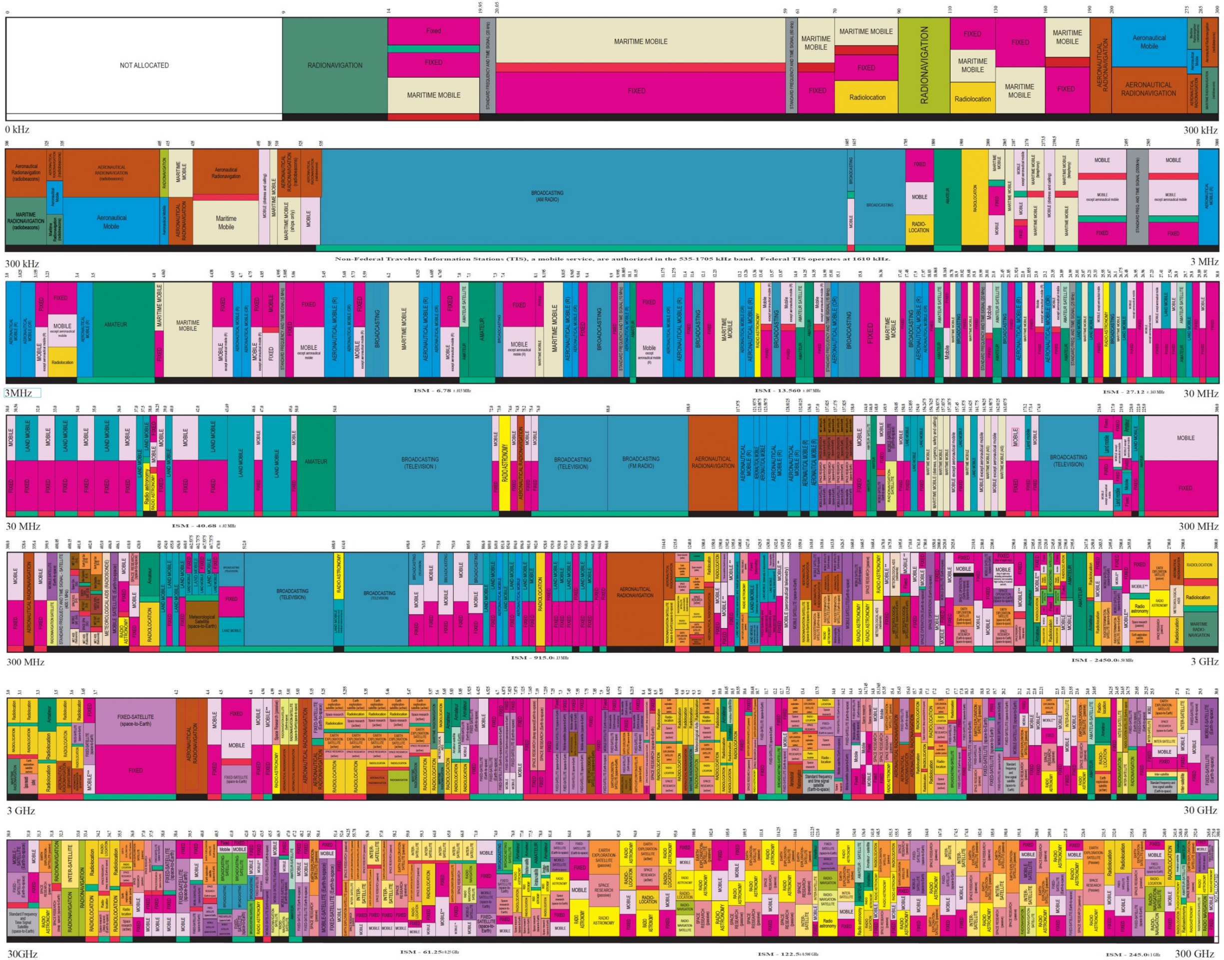


* EXCEPT AERONAUTICAL MOBILE (R)
** EXCEPT AERONAUTICAL MOBILE

PLEASE NOTE: THE SPACING ALLOTTED THE SERVICES IN THE SPECTRUM SEGMENTS SHOWN IS NOT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM OCCUPIED.

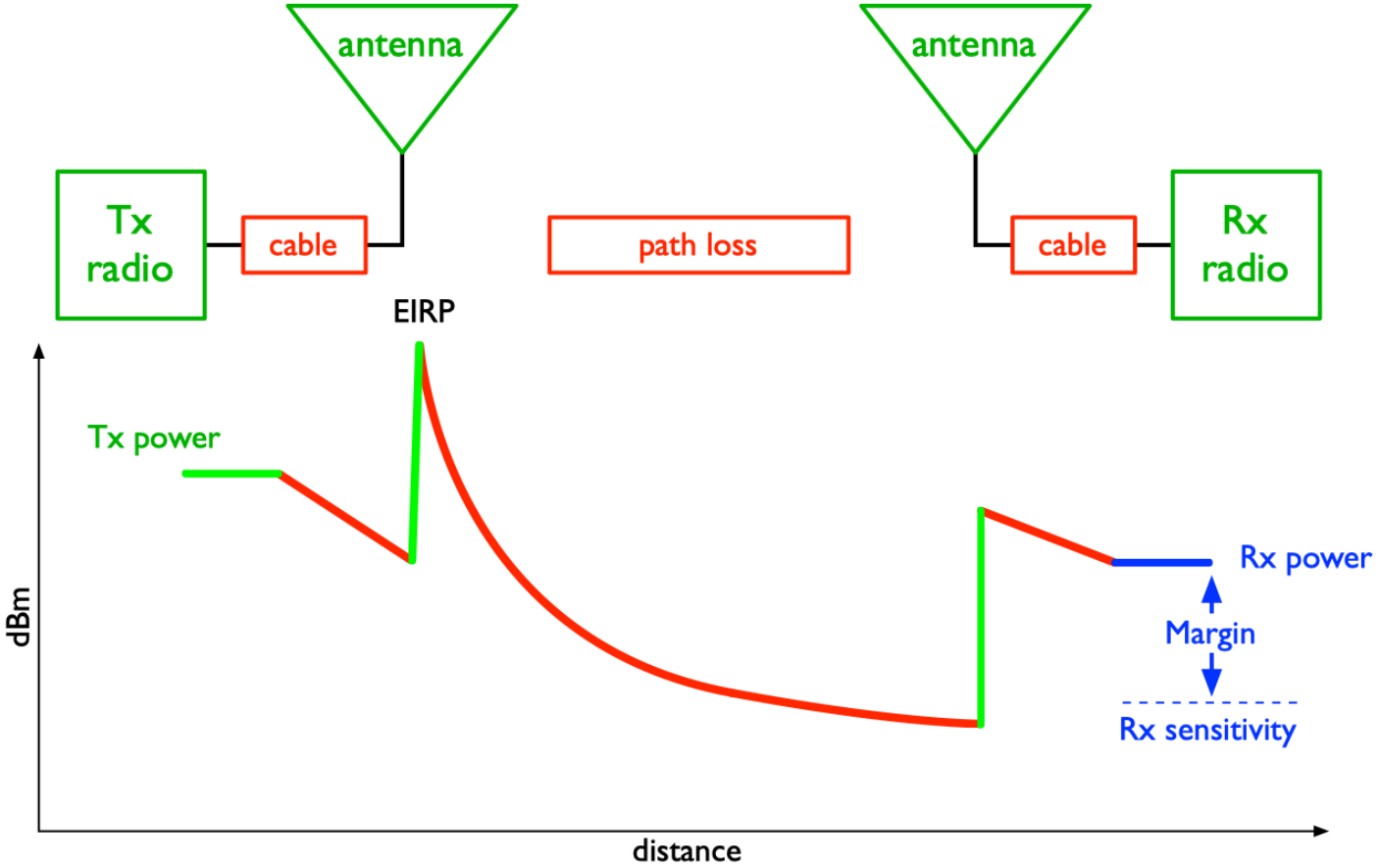
ISM bands

Industrial, **S**cientific and **M**edical Radio Bands

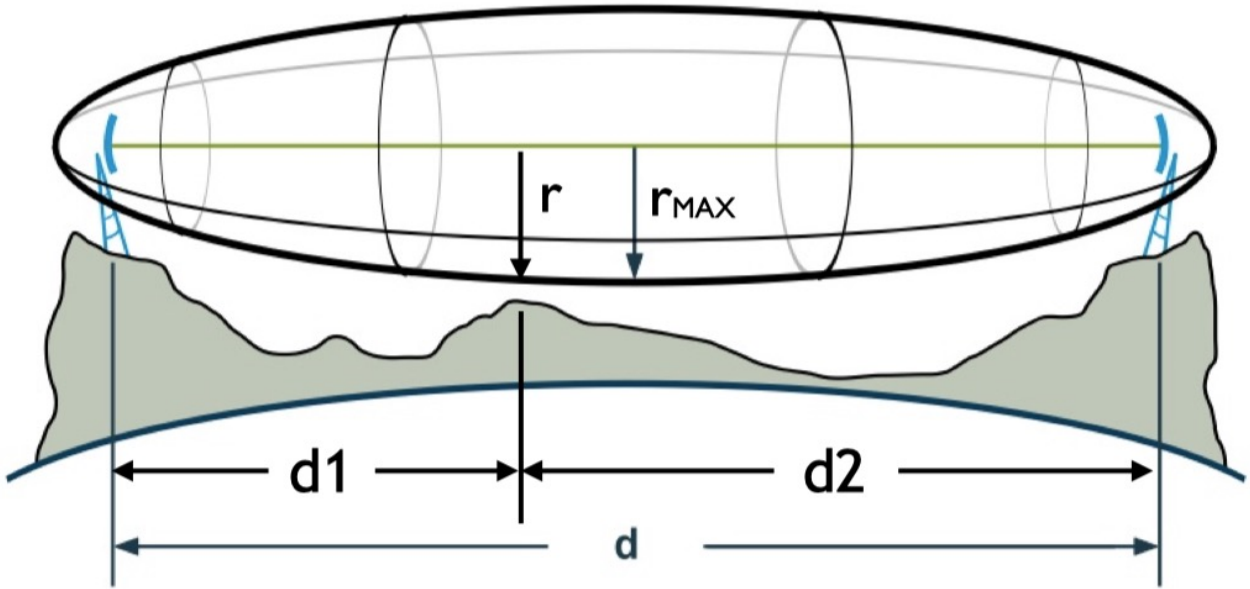
ISM Band Frequencies
6.765 - 6.795 MHz
13.553 - 13.567 MHz
26.957 - 27.283 MHz
40.66 - 40.70 MHz
83.996 - 84.004 MHz
167.992 - 168.008 MHz
433.05 - 434.79 MHz
886 - 906 MHz
2.400 - 2.500 MHz
5.725 - 5.875 MHz
24.0 - 24.25 GHz
61.0 - 61.5 GHz
122 - 123 GHz
244 - 246 GHz

f(space, time)

Power in a wireless system



Line of Sight and Fresnel Zones



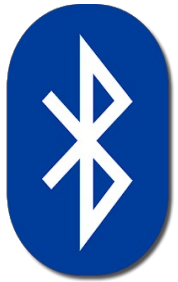
$$r = \sqrt{d1 * d2 * \lambda / d}$$

Options

We will consider the following options for IoT communications:

- Bluetooth and BLE
- WiFi
- Cellular based
- Satellite
- LPWAN

Bluetooth



79 channels 1 MHz wide and **frequency hopping** to combat interference in the crowded 2.4 GHz band.

Used mainly for speakers, health monitors and other short-range applications.

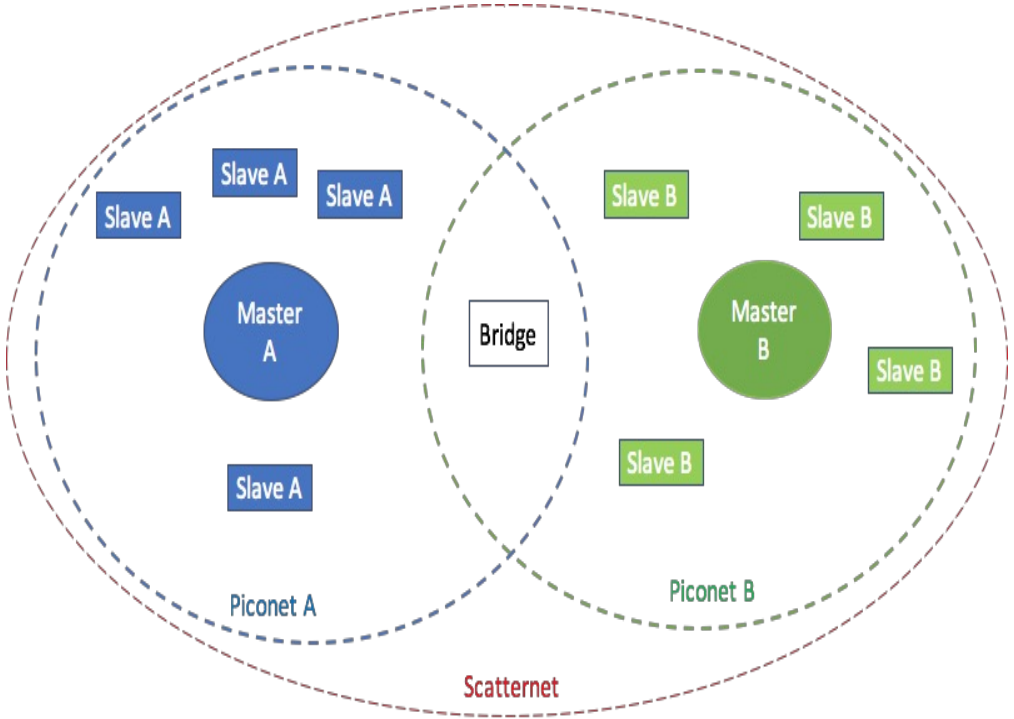
Bluetooth architecture

Master node controls up to 7 active slave nodes and up 255 inactive nodes, forming a **piconet**.

Several piconets can form a **scatternet** by leveraging bridging nodes associated to more than one master.

Slaves must communicate through the master node.

Bluetooth architecture



Bluetooth Low Energy (BLE)

Subset of Bluetooth 4.0, but stemming from an independent Nokia solution.

Smart Mesh.

40 channels 2 MHz wide and frequency hopping to combat interference.

Used in smartphones, tablets, smart watches, health and fitness monitoring devices.

RuuviTag

Wireless Temperature, Humidity, Air Pressure and Motion Sensor

RuuviTag Bluetooth Sensor

32,18€ / pc

Tax excl.

Shipping

Ruuvi Gateway

Ruuvi Gateway - Remote Monitoring for Sensors

Includes a 6-month Ruuvi Cloud Pro subscription plan activation code.

160,48€ / pc

Tax excl.

Shipping

BLE beacons

Battery Powered

32 Bytes packer broadcasted

Up to 2 years

No formatting in standard

5.0 255 bytes packet

iBeacon (Apple) (proprietary)

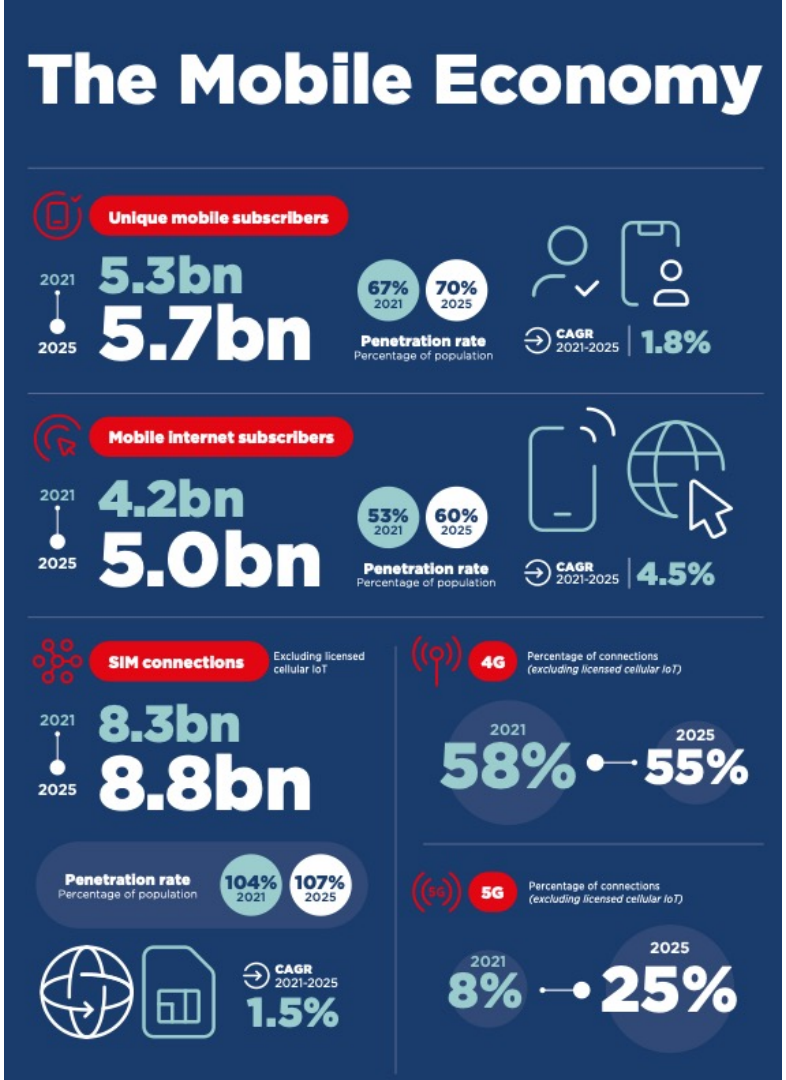
Eddystone (Google) (open source)

Facebook Bluetooth Beacon (pushing advertisement)

Bluetooth – characteristics

Range	10m
Multihop capabilities	no/yes
Battery consumption	low
Security	yes
Cost (device)	low
Cost (service)	free
Availability	good
Regulation	good

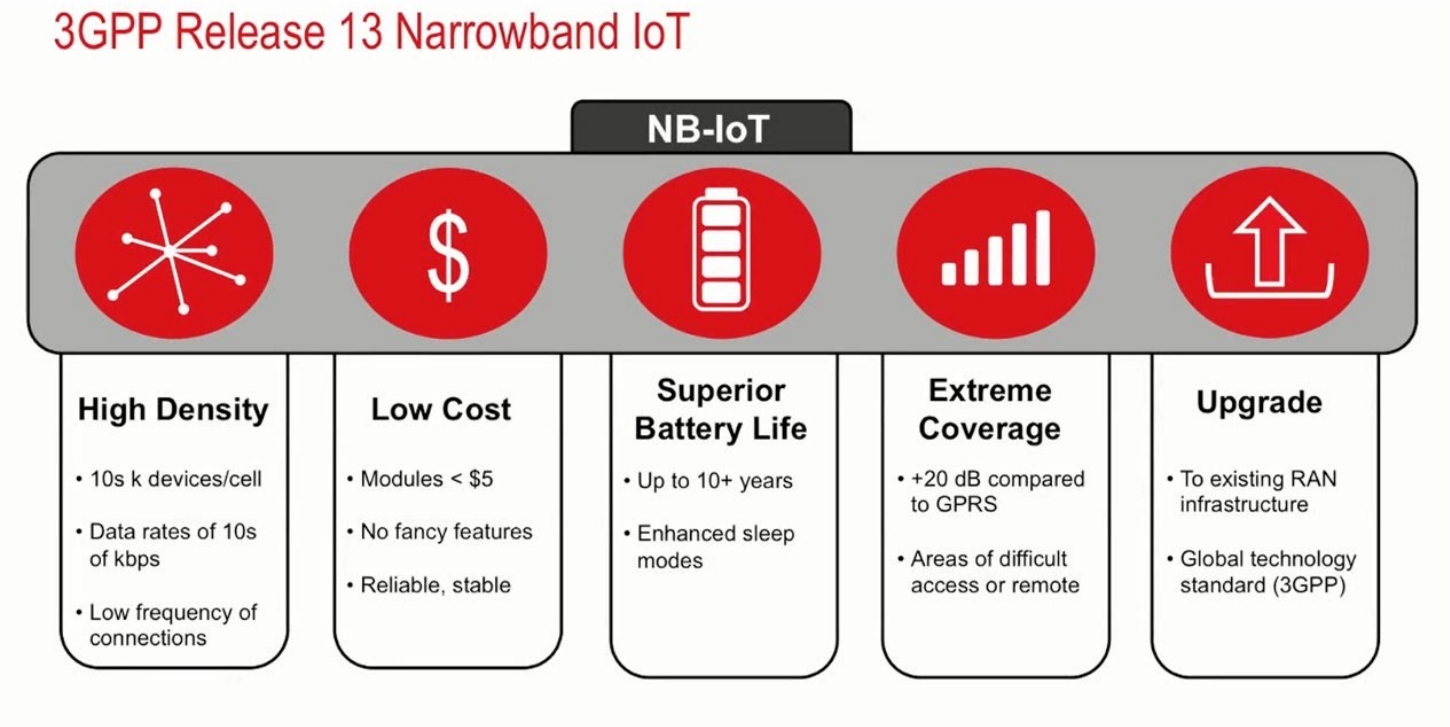
GSM


The Mobile Economy
Unique mobile subscribers
2021
5.3bn
2025
5.7bn
67%
2021
70%
2025
Penetration rate
Percentage of population
CAGR
2021-2025
1.8%
Mobile internet subscribers
2021
4.2bn
2025
5.0bn
53%
2021
60%
2025
Penetration rate
Percentage of population
CAGR
2021-2025
4.5%
SIM connections
Excluding licensed cellular IoT
2021
8.3bn
2025
8.8bn
Penetration rate
Percentage of population
104%
2021
107%
2025
CAGR
2021-2025
1.5%
4G
Percentage of connections
(excluding licensed cellular IoT)
2021
58%
2025
55%
5G
Percentage of connections
(excluding licensed cellular IoT)
2021
8%
2025
25%

3GPP

	LTE cat 0	LTE cat M1 (eMTC)	LTE cat NB1 (NB IoT)	EC-GPRS	LTE cat 1	GSM 900
DL BW	20 MHz	1.4 MHz	180 kHz	200 kHz	20 MHz	200 kHz
UL BW	20 MHz	1.4 MHz	180 kHz	200 kHz	20 MHz	200 kHz
DL Peak rate	1 Mb/s	1 Mb/s	250 kb/s	10 kb/s	10 Mb/s	22.8 kb/s
UL Peak rate	1 Mb/s	1 Mb/s	250 kb/s (Multitone) 20 kb/s (Single tone)	10 kb/s	5 Mb/s	22.8 kb/s
Duplex	half or full	half or full	half	half	full	full

3GPP


3GPP Release 13 Narrowband IoT
NB-IoT
High Density
• 10s k devices/cell
• Data rates of 10s of kbps
• Low frequency of connections
Low Cost
• Modules < $5
• No fancy features
• Reliable, stable
Superior Battery Life
• Up to 10+ years
• Enhanced sleep modes
Extreme Coverage
• +20 dB compared to GPRS
• Areas of difficult access or remote
Upgrade
• To existing RAN infrastructure
• Global technology standard (3GPP)

Telia first in Sweden with nationwide narrowband IoT

2018-05-24

Telia Company is the first operator in Sweden to bring the Narrowband IoT (NB-IoT) technology to its entire network. The new technology, designed for the Internet of Things, makes it possible to easily connect a huge number of sensors directly to the mobile network.

Narrowband IoT (NB-IoT) is a new communication technology that enables excellent coverage indoors, outdoors and in the ground. It is ideal for things that run on battery or only send data irregularly. NB-IoT allows for devices to be installed and connected in places that previously lacked coverage or were difficult to maintain regularly, such as far below ground or in the mountains, which opens up for completely new solutions and features.

GSM – characteristics

Range	infinite
Multihop capabilities	no
Battery consumption	medium
Security	yes
Cost (device)	medium
Cost (service)	high
Availability	good
Regulation	good

WiFi

Austin, TX – January 20, 2022 – Wi-Fi® users demand more efficient, reliable, and secure connectivity in 2022. 6 GHz regulatory approvals, remote-hybrid work scenarios, and complex connectivity systems in home, enterprise, and Internet of Things (IoT) environments will only continue to drive demand for high capacity, low latency Wi-Fi. In 2022, nearly 18 billion Wi-Fi devices will be in use, and more than 4.4 billion devices will ship this year.[1] As Wi-Fi momentum mounts, Wi-Fi Alliance® looks ahead at four Wi-Fi trends expected in 2022.

Credit: WiFi Aliance

IEEE 802.11 Amendments

Standard	a	b	g	n	ac	ad	af	ah
Year approved	1999	1999	2003	2009	2012	2014	2014	2016
Max data	54 Mb/s	11 Mb/s	54 Mb/s	600 Mb/s	3.2 Gb/s	6.76 Gb/s	426 Mb/s	from 150 kb/s to 347 Mb/s
Frequenc y band	5 GHz	2.4 GHz	2.4 GHz	2.4/ 5 GHz	5 GHz	60 GHz	54 to 790 MHz	below 1 GHz
Channel width	20 MHz	20 MHz	20 MHz	20/40 MHz	20 to 160 MHz	2160 MHz	6 - 8 MHz	1-2 MHz
RF chains	1X1 SISO	1X1 SISO	1X1 SISO	up to 4X4 MIMO	Up to 8X8 MIMO, MU	1X1 SISO	up to 4X4 MIMO	1X1 SISO

802.11ah (WiFi HaLow)

Sub 1 GHz, most commonly 900 MHz

Low power, long range WiFi, less attenuated by walls and vegetation.

Up to 1 km range.

Lower power consumption thanks to sleep mode capabilities.

1, 2, 4, 8 and 16 MHz channels.

Competes with Bluetooth, speed from 100 kb/s to 40 Mb/s.

Support of Relay AP to further extend coverage.

IEEE 802.11 Amendments

First Commercial 802.11ah (HaLow) Wireless Access Point

A benefit of 802.11ah is extended range, making it useful for rural communications and offloading cell phone tower traffic. Among other benefits, AP-100AH is a revolutionary access point combining performance with unequivocal scalability and range (675 simultaneous connections and up to 3 km range).

https://www.silextechnology.com/connectivity-solutions/wifi-access-point/ap-100ah

WiFi – characteristics

Range	1km
Multihop capabilities	no
Battery consumption	mid
Security	yes
Cost (device)	low
Cost (service)	free
Availability	good
Regulation	good

Satellite

Iridium 9603

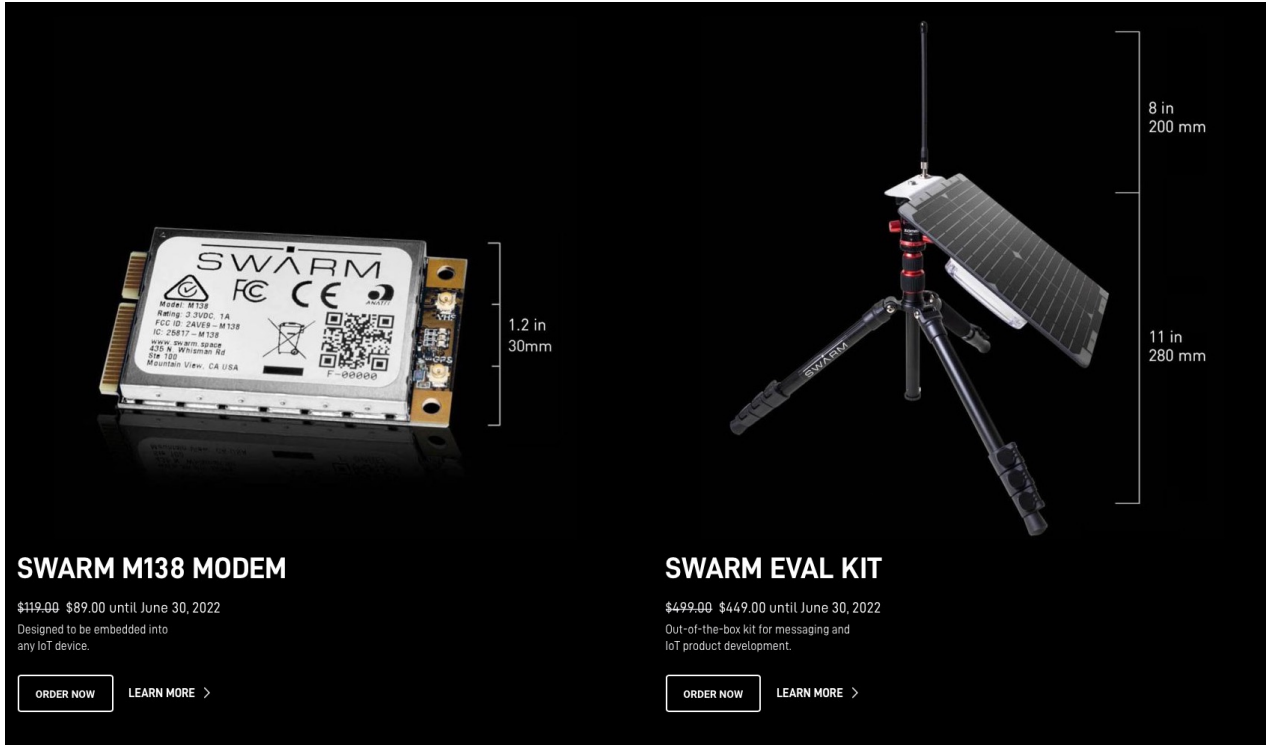
Power

- Supply input voltage range: 5.0V +/- .5V DC
- Supply input voltage ripple: <40mV pp
- Idle Current (peak): 156mA
- Idle Current (average): 34mA
- Transmit Current (peak): 1.3A
- Transmit Current (average): 145mA
- Receive Current (peak): 156mA
- Receive Current (average): 39mA
- SBD message transfer – average current: 158mA
- SBD message transfer – average power: <= 0.8 W

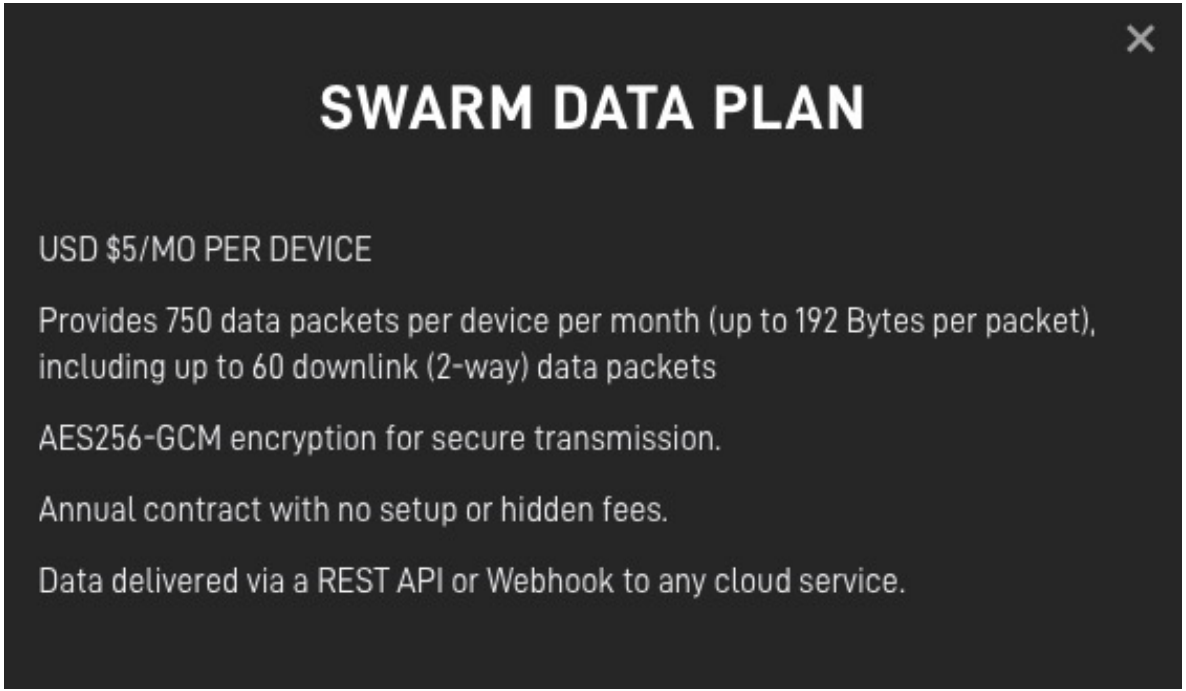
Satellite

Bundle	per Credit	Bundle Price
100 Credits	£0.11	£11.00
200 Credits	£0.10	£20.00
500 Credits	£0.09	£45.00
1000 Credits	£0.08	£80.00

Satellite


SWARM
1.2 in
30mm
8 in
200 mm
11 in
280 mm
SWARM M138 MODEM
$119.00 $89.00 until June 30, 2022
Designed to be embedded into
any IoT device.
ORDER NOW
LEARN MORE
SWARM EVAL KIT
$499.00 $449.00 until June 30, 2022
Out-of-the-box kit for messaging and
IoT product development.
ORDER NOW
LEARN MORE

Satellite


SWARM DATA PLAN
USD $5/MO PER DEVICE
Provides 750 data packets per device per month (up to 192 Bytes per packet), including up to 60 downlink (2-way) data packets
AES256-GCM encryption for secure transmission.
Annual contract with no setup or hidden fees.
Data delivered via a REST API or Webhook to any cloud service.

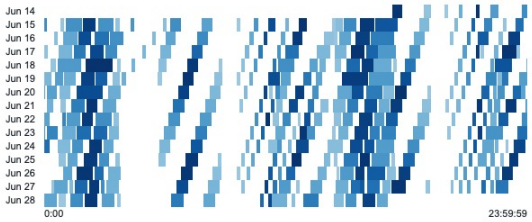
Satellite

SWARM

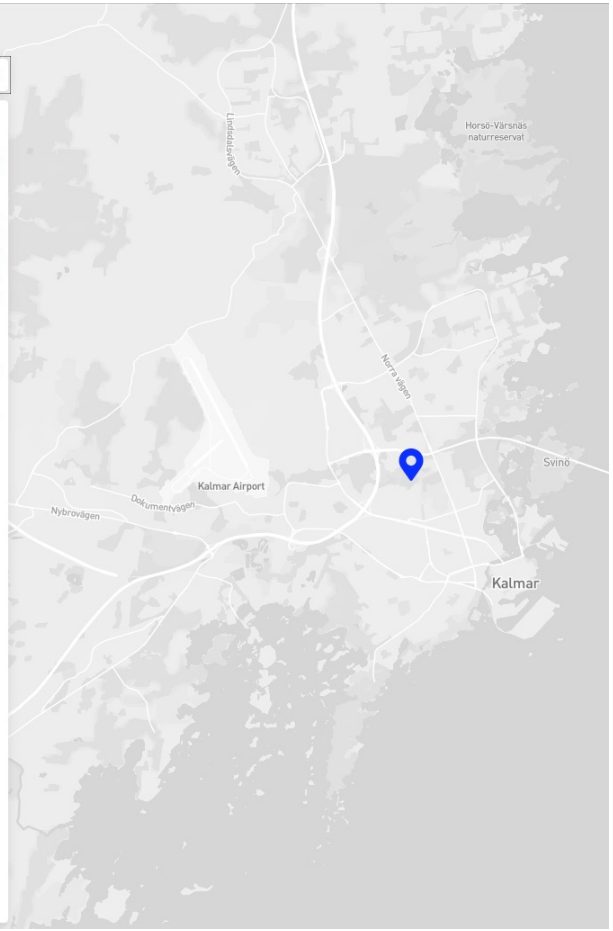
Kalmar, Kalmar, Sweden

Upcoming Satellite Passes

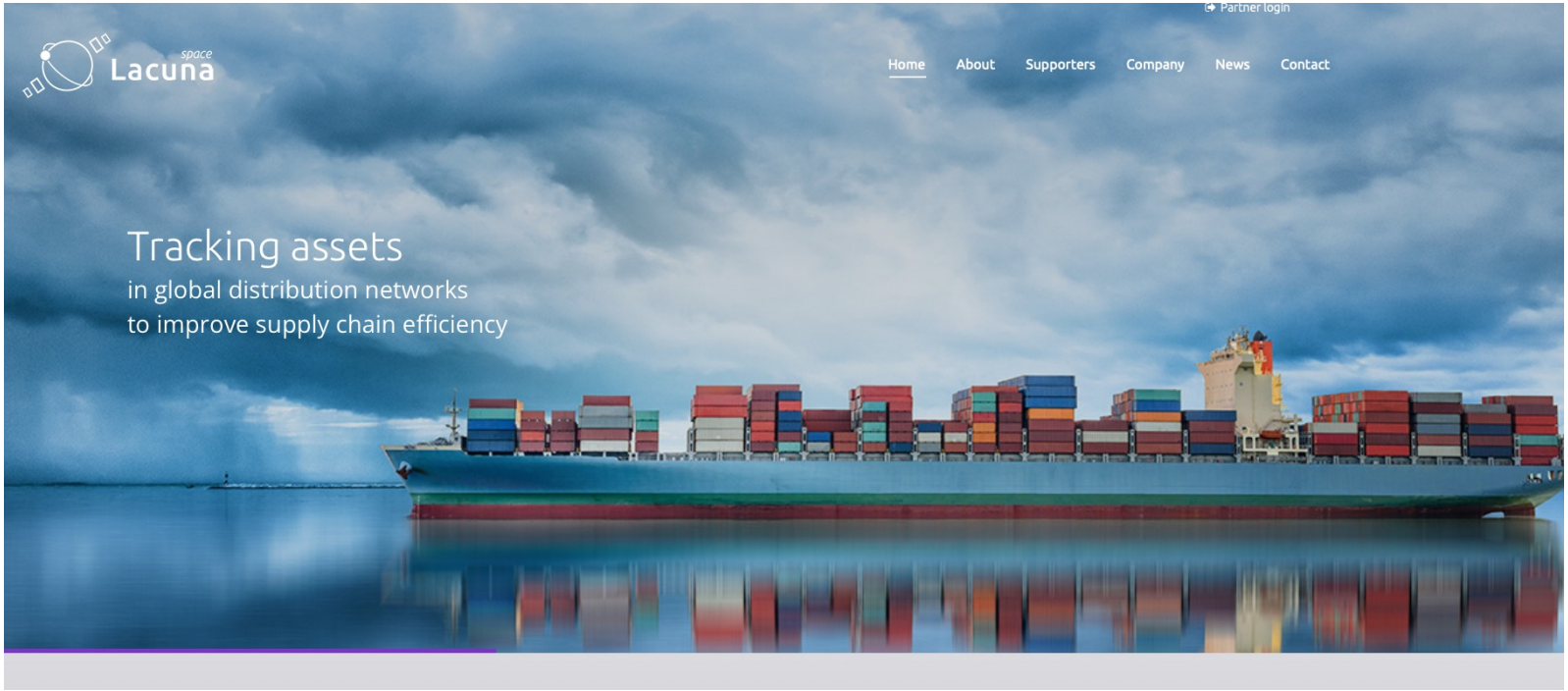
As of Jun 14, 2022 17:17:34 GMT+2



Time	Duration	Max Elev.
Jun 14 17:17:40 to 17:48:22 GMT+2	00:30:42	87.7°
Jun 14 18:51:50 to 19:12:22 GMT+2	00:20:32	18.2°
Jun 14 19:53:59 to 20:04:02 GMT+2	00:10:03	15.1°
Jun 14 20:36:56 to 20:48:09 GMT+2	00:11:13	29.8°
Jun 14 21:26:44 to 21:38:35 GMT+2	00:11:51	86.9°
Jun 14 22:09:49 to 22:35:30 GMT+2	00:25:41	39.8°
Jun 14 23:43:33 to Jun 15 00:09:12 GMT+2	00:25:39	47.0°
Jun 15 00:48:30 to 01:00:00 GMT+2	00:11:30	17.0°
Jun 15 01:03:22 to 01:52:06 GMT+2	00:48:44	44.9°
Jun 15 01:55:25 to 02:34:01 GMT+2	00:38:36	84.2°
Jun 15 02:40:07 to 03:26:10 GMT+2	00:46:03	44.8°
Jun 15 03:30:29 to 03:45:47 GMT+2	00:15:18	17.8°
Jun 15 04:17:26 to 04:28:46 GMT+2	00:11:20	43.2°
Jun 15 05:54:55 to 06:05:26 GMT+2	00:10:31	20.5°



Satellite


Partner login
space
Lacuna
Home
About
Supporters
Company
News
Contact
Tracking assets
in global distribution networks
to improve supply chain efficiency

Satellite

Lacuna and Semtech Expand LoRaWAN® Coverage through IoT to Satellite Connectivity

Companies to collaborate to accelerate Internet of Things (IoT) adoption with affordable and simplified connectivity

CAMARILLO, Calif., Jan. 11, 2022 – Semtech Corporation (Nasdaq: SMTC), a leading global supplier of high performance analog and mixed-signal semiconductors and advanced algorithms, today announced a joint initiative with Lacuna Space to further increase coverage and resilience of LoRaWAN® connectivity.

Satellite – characteristics

Range	infinite
Multihop capabilities	no
Battery consumption	high
Security	no
Cost (device)	medium
Cost (service)	medium
Availability	low
Regulation	poor

LPWAN

LPWAN

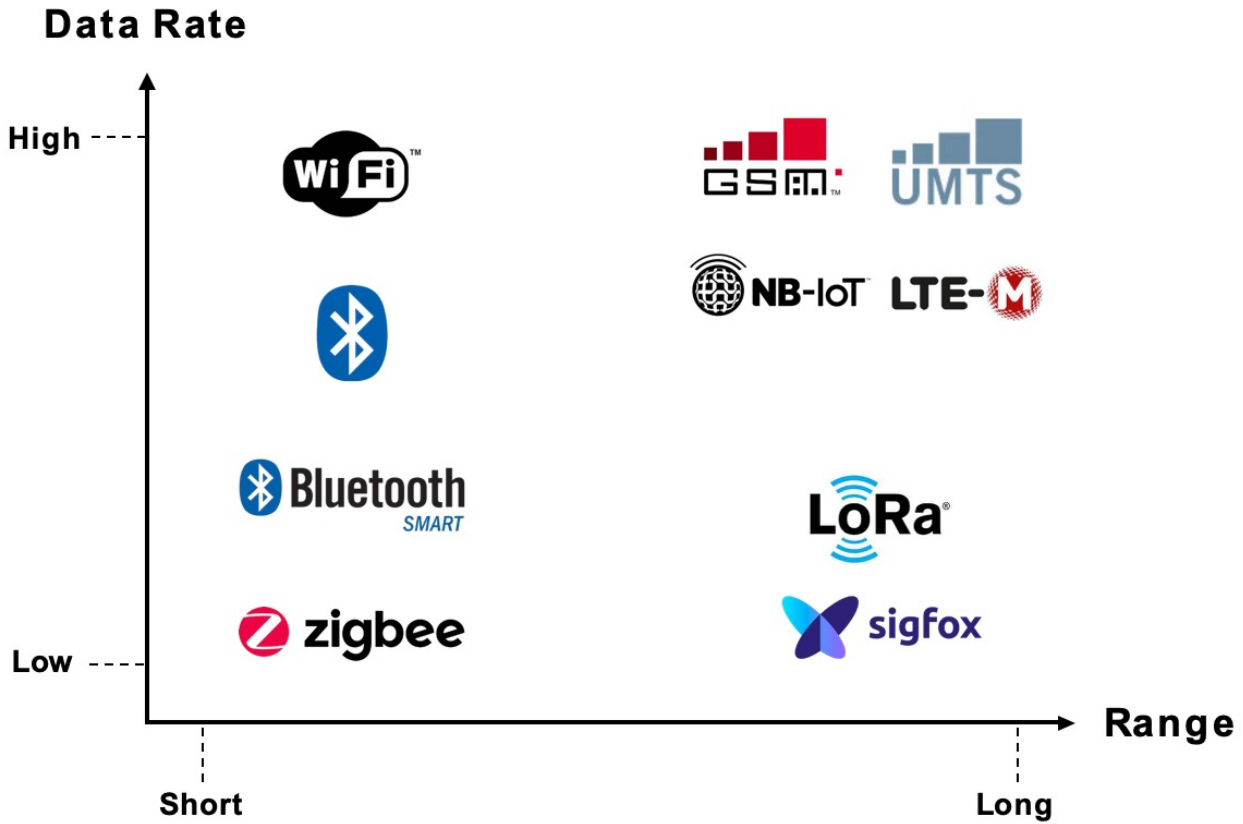
Low Power, Wide Area Networks

Connectivity designed specifically for IoT
Low data throughput = High sensitivity = Long range

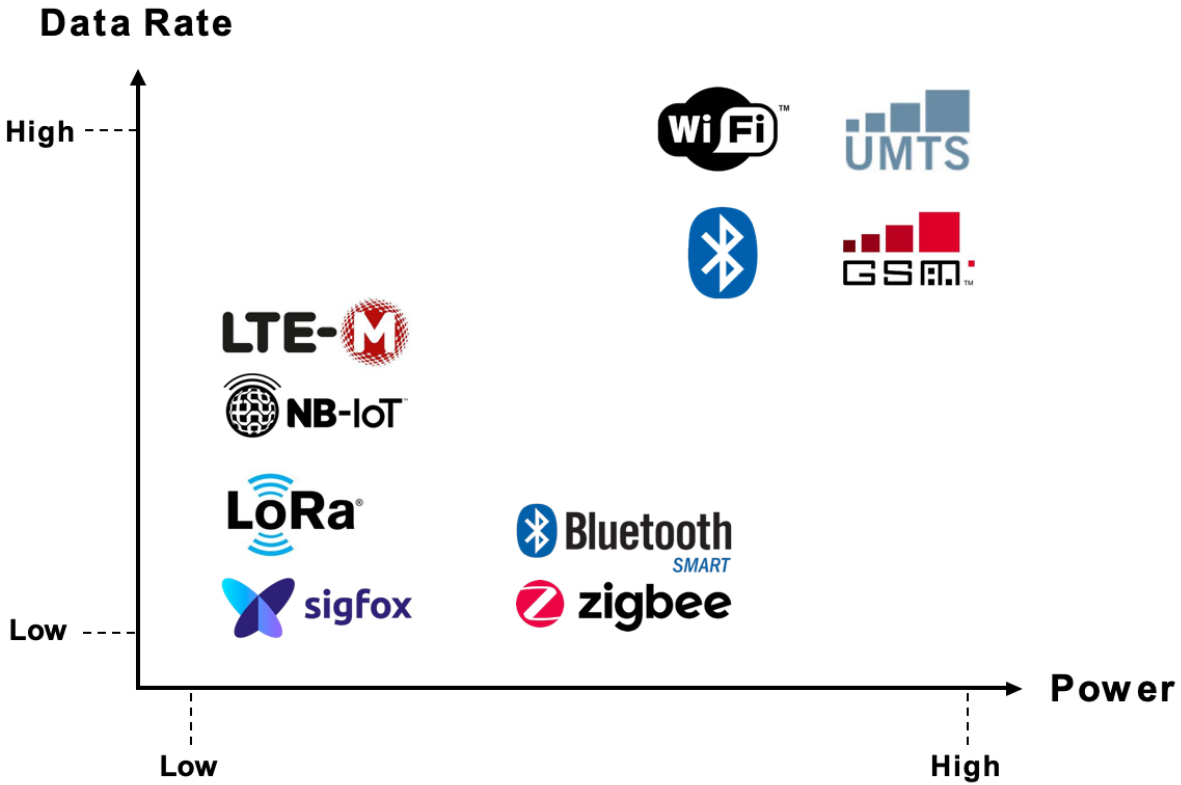
(Relatively) low cost

Using licensed or unlicensed spectrum

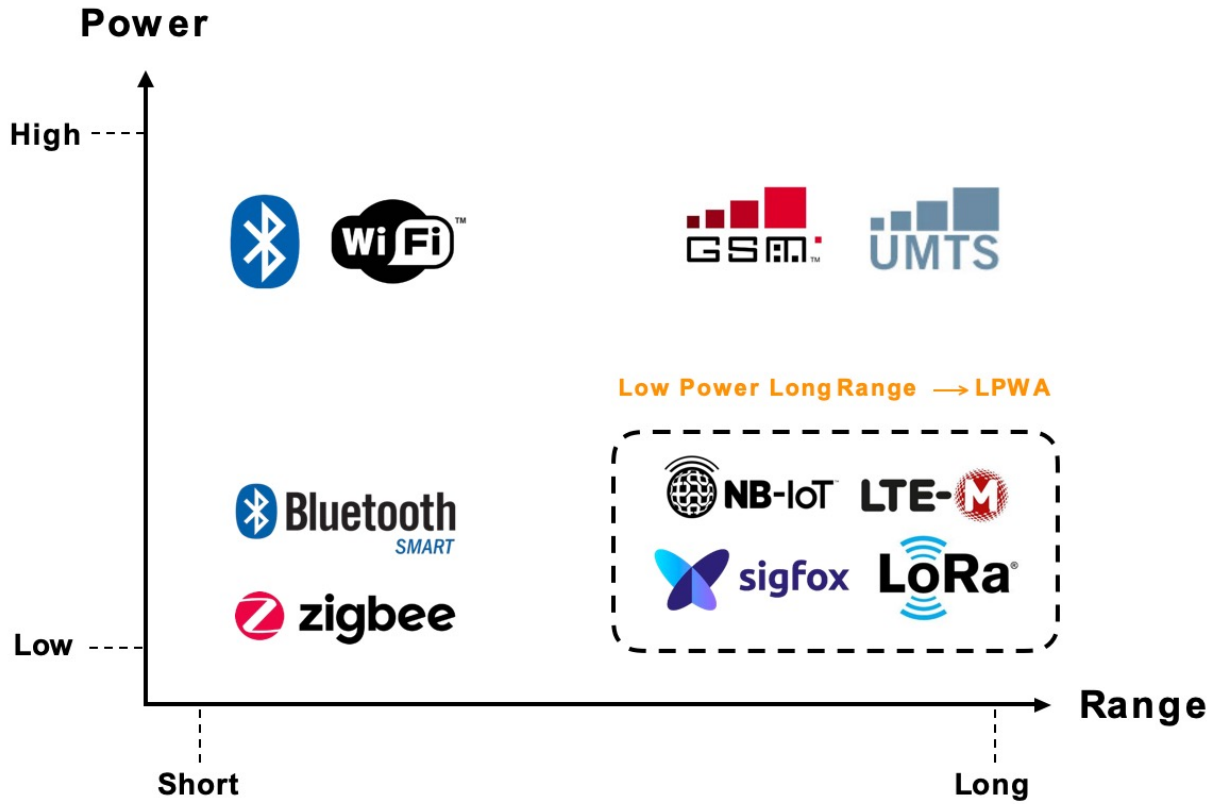
LPWAN


Data Rate
High
Low
Range
Short
Long
Wi Fi
GSM
UMTS
NB-IoT
LTE-M
Bluetooth
SMART
LoRa
zigbee
sigfox

LPWAN


Data Rate
High
Low
Low
High
Power
Wi Fi
UMTS
GSM
LTE-M
NB-IoT
LoRa
sigfox
Bluetooth
SMART
zigbee

LPWAN


Power
High
Low
Short
Long
Range
Wi Fi
GSM
UMTS
Low Power Long Range → LPWA
Bluetooth SMART
zigbee
NB-IoT
LTE-M
sigfox
LoRa

Sigfox

Ultra narrowband technology designed for low throughput and few messages/day. Low consumption, low cost

High receiver sensitivity: -134 dBm at 600 b/s or - 142 dBm at 100 b/s on a 100 Hz channel, allows 146 to 162 dB of link budget.

Each message transmitted 3 times in 3 different frequencies offering resilience to interference.

Sigfox

Unlicensed frequencies: 868 MHz in Europe, 915 MHz in US.

Maximum of **140 uplink messages/day with 12 octets payload, 26 octets total with overhead.**

Maximum of 4 downlink messages/day with 8 octets payload.

Mobility restricted to 6 km/h.

Sigfox

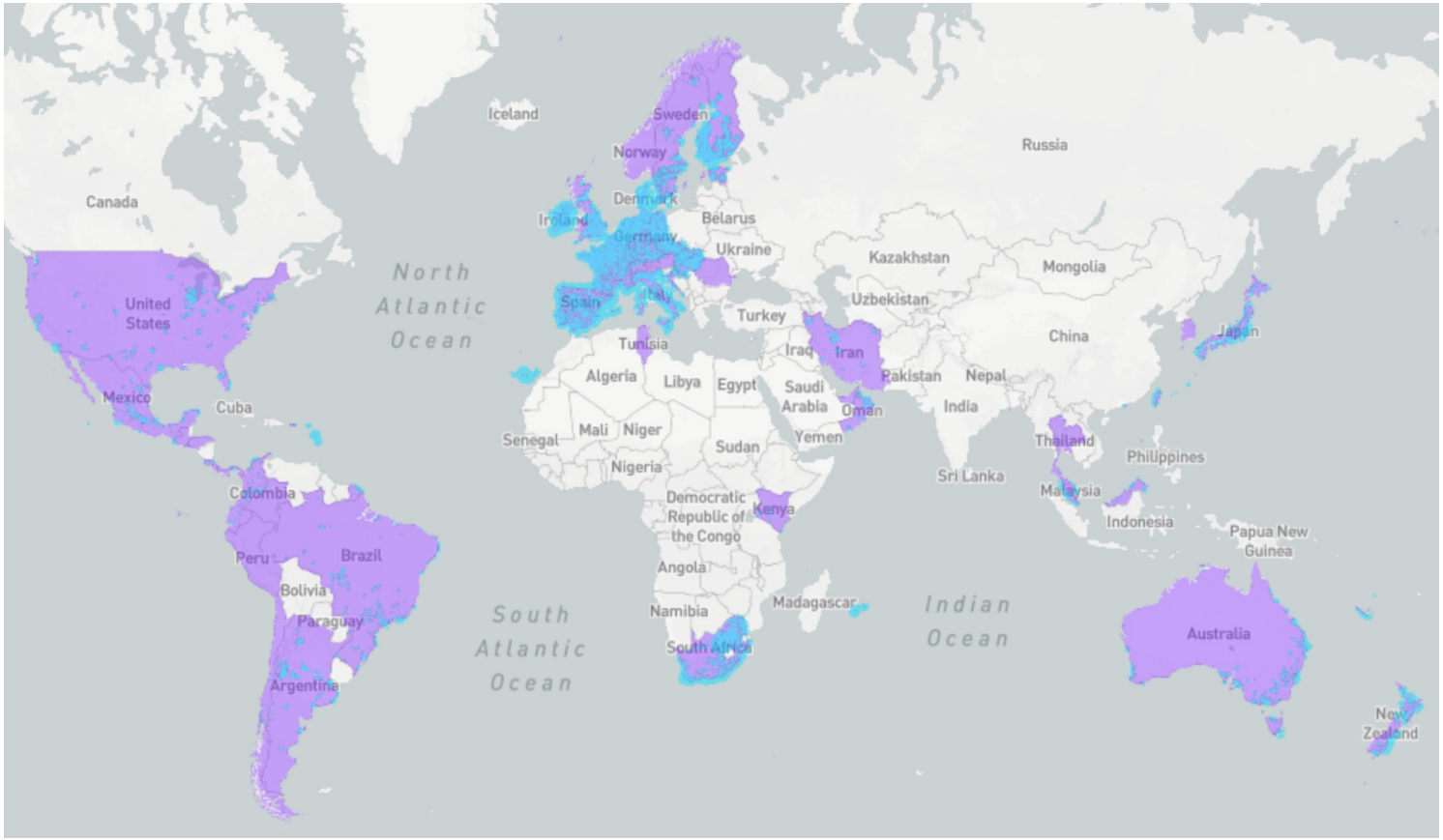
Partnerships with cellular providers with an aim to worldwide penetration.

Many **network operators** worldwide offer Sigfox services on a subscription basis.

Coarse geolocation capability without GPS.

Roaming capability.

Sigfox coverage



What is LoRa

Wireless modulation technology, based on Semtech's proprietary Chirp Spread Spectrum (CSS)

Physical (PHY) layer for long range wireless communications
Operates in the license-free Industrial Scientific Medical (ISM) bands all around the world

Based on spread spectrum, trading bandwidth for S/N.

What is LoRa

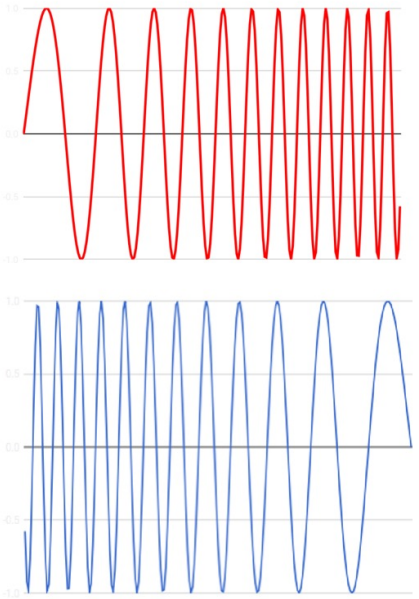
Sub-GHz frequency, e.g: 433, 868, 915 MHz, depends on the country's regulation

Regulated power, duty-cycle, and bandwidth.

E.g: in EU, **1%** per sub-band duty-cycle limitation (per hour, meaning transmission is allowed for 36 sec in each 1 hour)

LoRa modulation

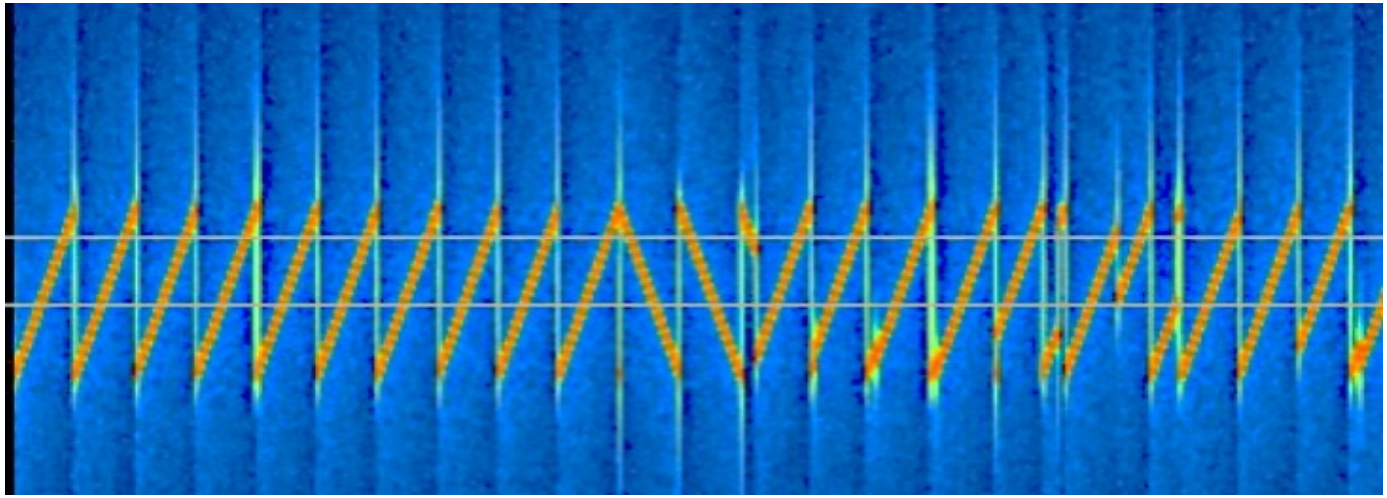
Uses linearly varying frequency pulses called "**chirps**" inspired in radar signals.



Up-chirp:
sinusoidal signal of linearly increasing frequency

Down-chirp:
sinusoidal of linearly decreasing frequency

LoRa Physical Layer



Preamble: at least 10 up-chirps followed by 2.25 down-chirps

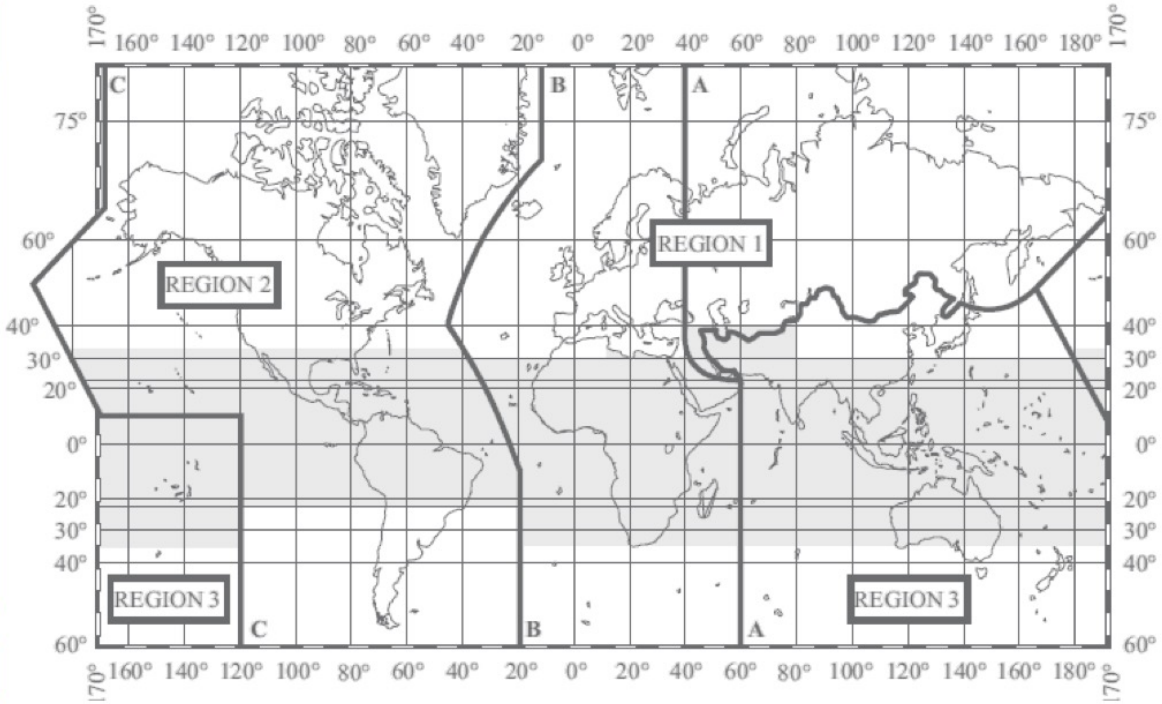
Data: information transmitted by the instantaneous frequency transitions

LoRa physical layer consists of many parameters which can be configured into 6720 different settings!

SeRing	Values	DeSnition	ETects
Bandwidth	125, …„500 kHz	Width of spectrum occupied by chirp	A higher bandwidth is required for transmiRing data at high rates (1 kHz = 1kcps). However, increasing this parameter decreases the communication range and sensitivity.
Spreading Factor	2^6, …„2^{12} chips/ symbol	Number of bits encoded per symbol. Symbol is RF state representing some quantity of information. SF12 means 2^{12} chips/symbol, 12 bits of data	A higher spreading factor (*SF*) increases the communication range, radio sensitivity, and the signal-to-noise ratio (SNR). However, energy consumption consequently increases.
Coding Rate	1,…„4 or 4/5, …„4/8	Propoaion of transmiRed bits that caries actual data, as opposed to error correction bits. CR1 · 4/(4+1) = 4/5	Bigger coding rates increase the protection against decoding errors and intecerence bursts at the expense of longer packets, longer air time, and higher power consumption.
Transmission Power	−4, …„20 dBm	Transmission power can be adjusted from −4 to 20 dBm, in 1dB steps. Because of hardware implementation limits, the range is o<en limited to 2 to 20 dBm.	The signal-to-noise ratio is increased by increasing the transmission power at the cost of energy expenditure.
Carrier Frequency	137,…„1020 MHz	CF represents the central transmission frequency used in a band, can be programmed between 137 MHz to 1020 MHz, in steps of 61 Hz.	Lower frequency enables to achieve higher communication ranges for the same transmission power. However, selected CF needs to comply with country's regulation.

LoRa frequency bands

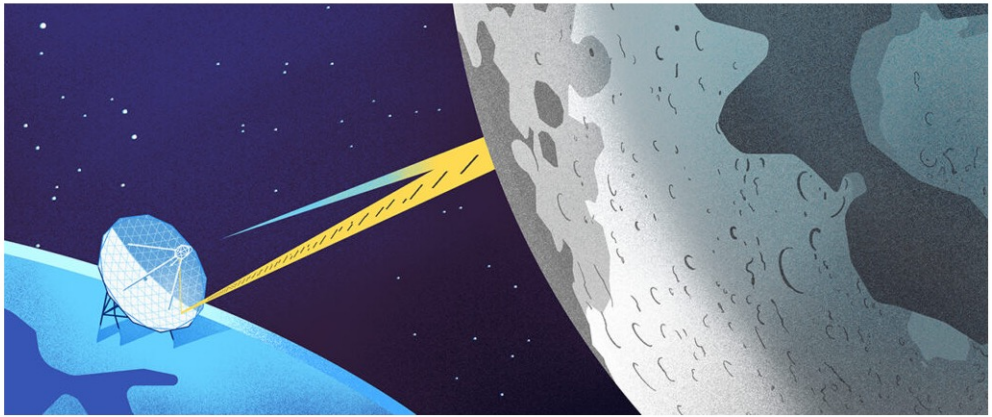
Countries	Frequency band review	Max. output power
EU	868 MHz	14 dBm
USA	915 MHz	20 dBm
Korea	900 MHz	14 dBm
Japan	920 MHz	
Malaysia	862 to 875 MHz	20 dBm
Philippines	868 MHz	
Vietnam	920 to 925 MHz	
India	865 to 867 MHz	
Singapore	922 MHz	
Thailand	920 to 925 MHz	
Indonesia		
ANZ	915 to 928 MHz	
Taiwan	920 to 925 MHz	
China	470 to 510 MHz	17 dBm



LoRa capabilities

First LoRa® message bounced off the moon

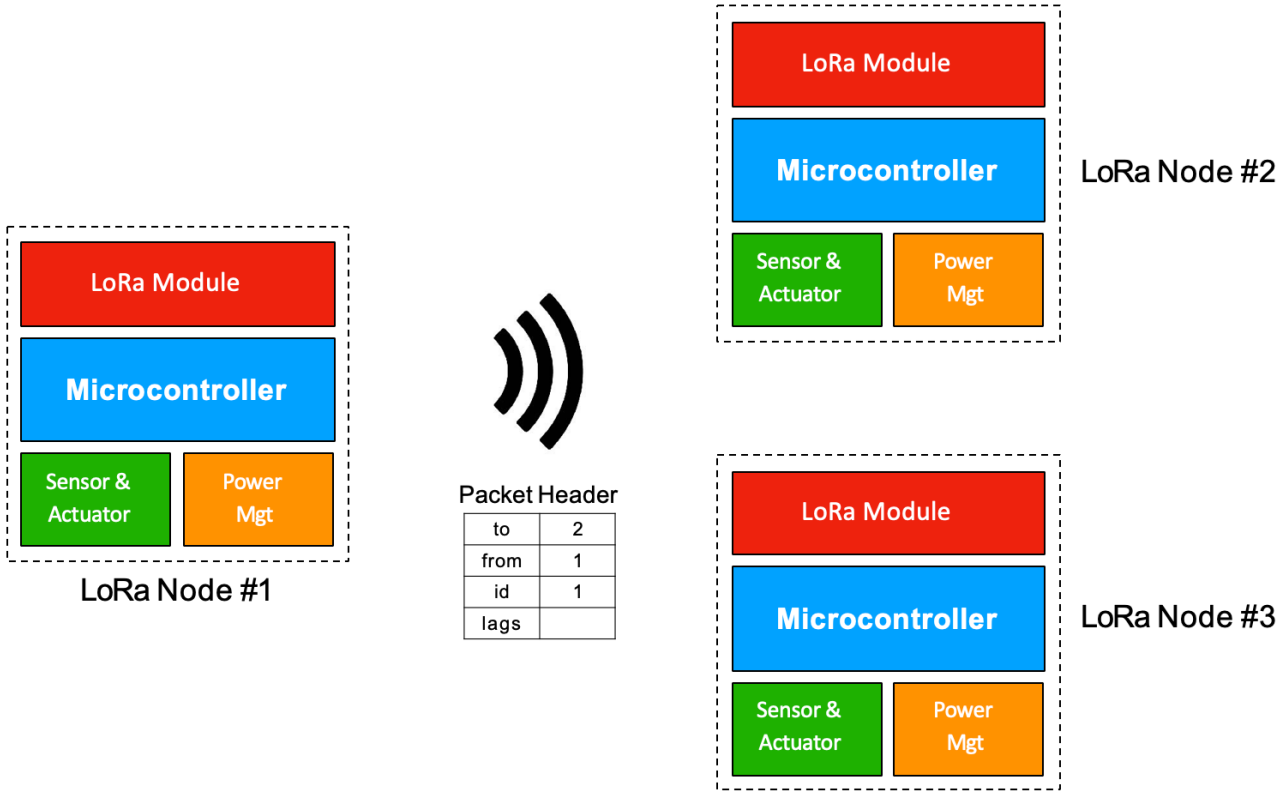
24 November 2021



For the first time ever we bounced a LoRa® message off the moon on October 5th 2021, using the Dwingeloo radio telescope. This first was achieved by a team consisting of Jan van Muijlwijk (CAMRAS, PA3FXB), Tammo Jan Dijkema (CAMRAS), Frank Zeppenfeldt (ESA, PD0AP) and Thomas Telkamp (Lacuna Space, PA8Z). The signal traveled an amazing distance of 730,360 km, which to our knowledge is the furthest distance a LoRa® modulated message has ever traveled.

For a short moment the entire message was in space, in between the Earth and the Moon. We transmitted the signal with a Semtech LR1110 RF transceiver chip (in the 430-440 Mhz amateur band), amplified to 350 Watt, using the 25 meter dish of the telescope. Then, 2.44 seconds later, it was received by the same chip. One of the messages even contained a full LoRaWAN® frame.

LoRa nodes


LoRa Module
Microcontroller
Sensor & Actuator
Power Mgt
LoRa Node #1
Packet Header
to 2
from 1
id 1
lags
LoRa Module
Microcontroller
Sensor & Actuator
Power Mgt
LoRa Node #2
LoRa Module
Microcontroller
Sensor & Actuator
Power Mgt
LoRa Node #3

What is LoRaWAN

Communications protocol and architecture utilizing the LoRa physical layer

Open Source and freely available, specified by LoRa Alliance

Star of Starts Topology.

Nodes connect to multiple gateways

What is LoRaWAN

Adaptive Data Rate (ADR) to improve performance

Built-in multiple levels of security: network or application level encryption, frame counter, etc

LoRaWAN end device/mote

Communicates with LoRaWAN gateways, never directly with other motes.

Has 64 bit globally unique identifier: **DevEUI**.

When joining a network, it receives a 32 bit unique identifier: DevAddr.

Defined 3 device classes: A, B, and C

LoRaWAN device classes

Class A

Device-initiated communication; lowest power

Devices are typically in deep sleep and send messages on intervals and/or events

After uplink transmission, device opens two receive windows at specified times for downlink messages

Best fit for most battery-powered sensor applications

Class B

Time-synchronized communication, deterministic downlink

Extend Class A by adding scheduled receive windows for downlink messages from backend

Using time-synchronized beacons transmitted by the gateway, the devices periodically open receive windows

Best for most downlink intensive applications

Class C

Network-initiated communication; lowest latency

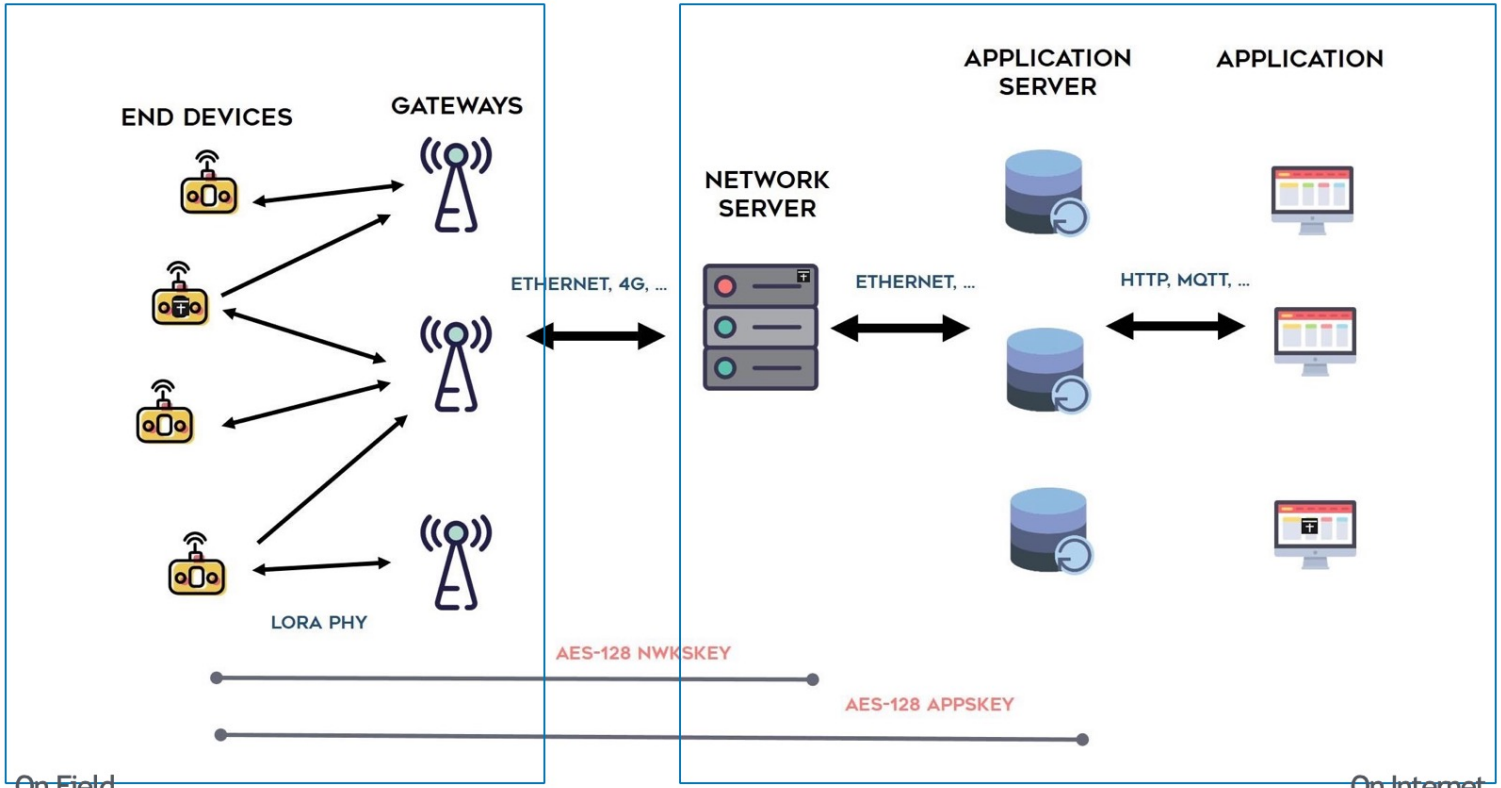
Extend Class A by keeping the receive windows open unless uplink-transmitting

The backend can send downlink message at any given time

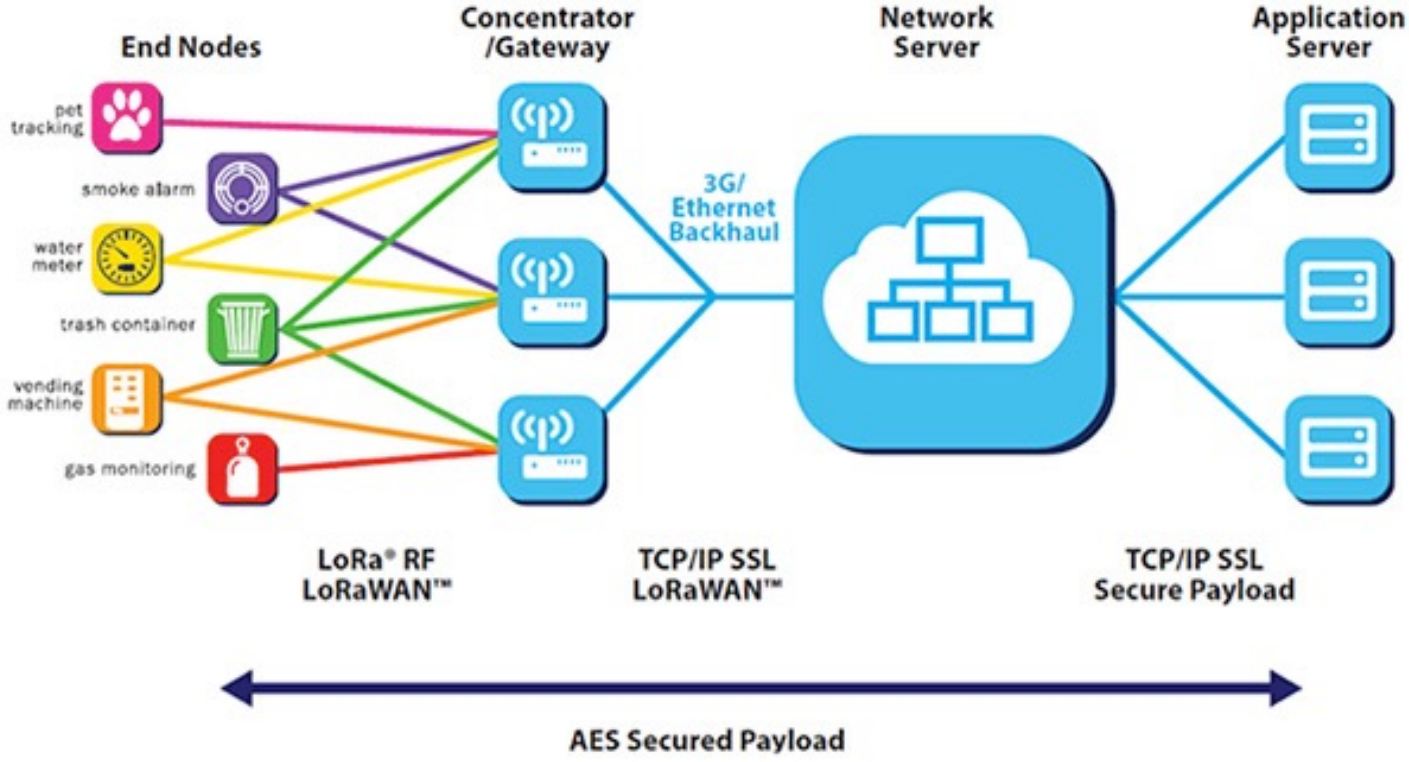
Best for downlink intensive applications that require low latencies, non battery-powered

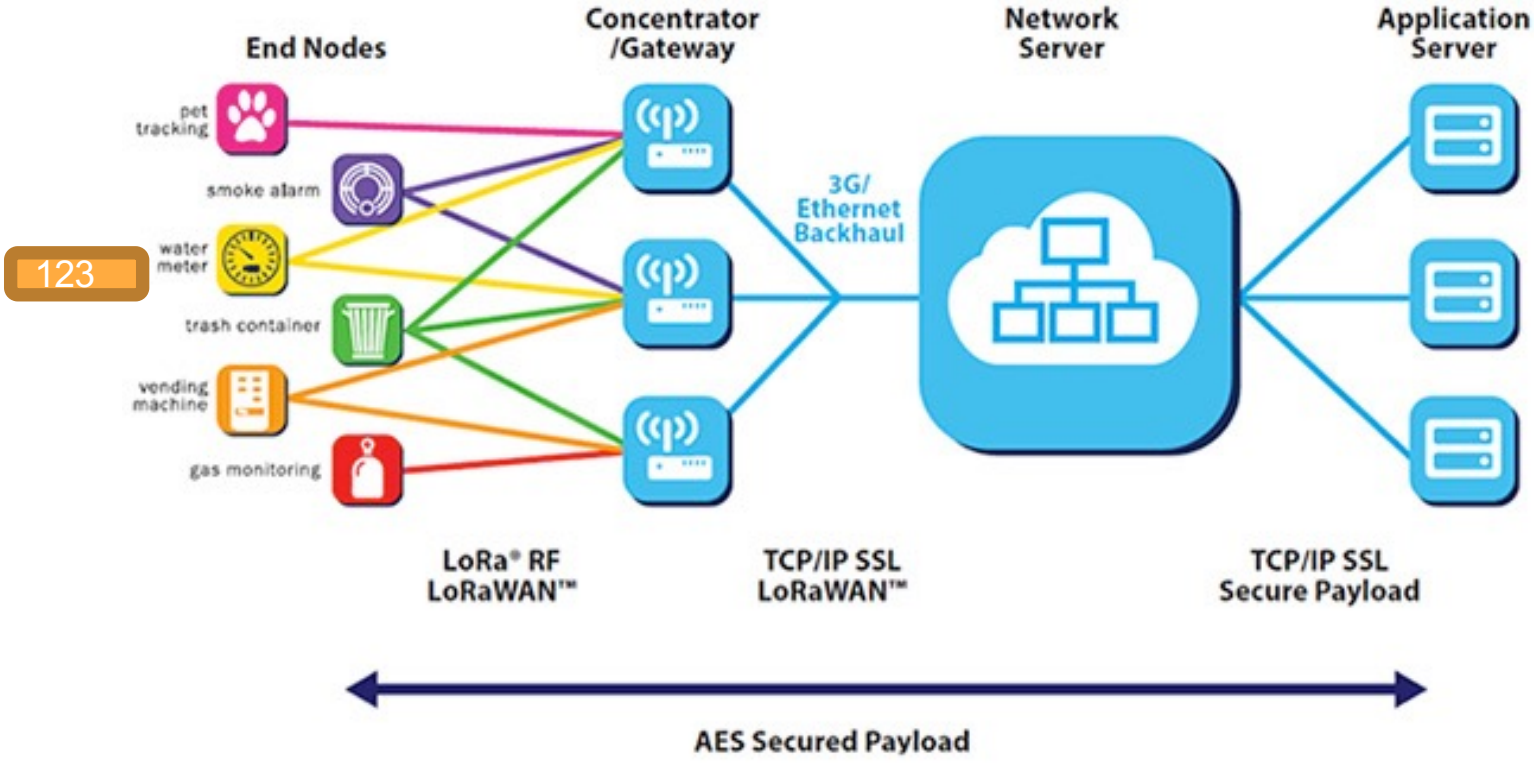
ICTP

LoRaWAN architecture



Source: http://www.frugalprototype.com/technologie-lora-reseau-lorawan/


End Nodes
Concentrator /Gateway
Network Server
Application Server
pet tracking
smoke alarm
water meter
trash container
vending machine
gas monitoring
3G/ Ethernet Backhaul
LoRa® RF LoRaWAN™
TCP/IP SSL LoRaWAN™
TCP/IP SSL Secure Payload
AES Secured Payload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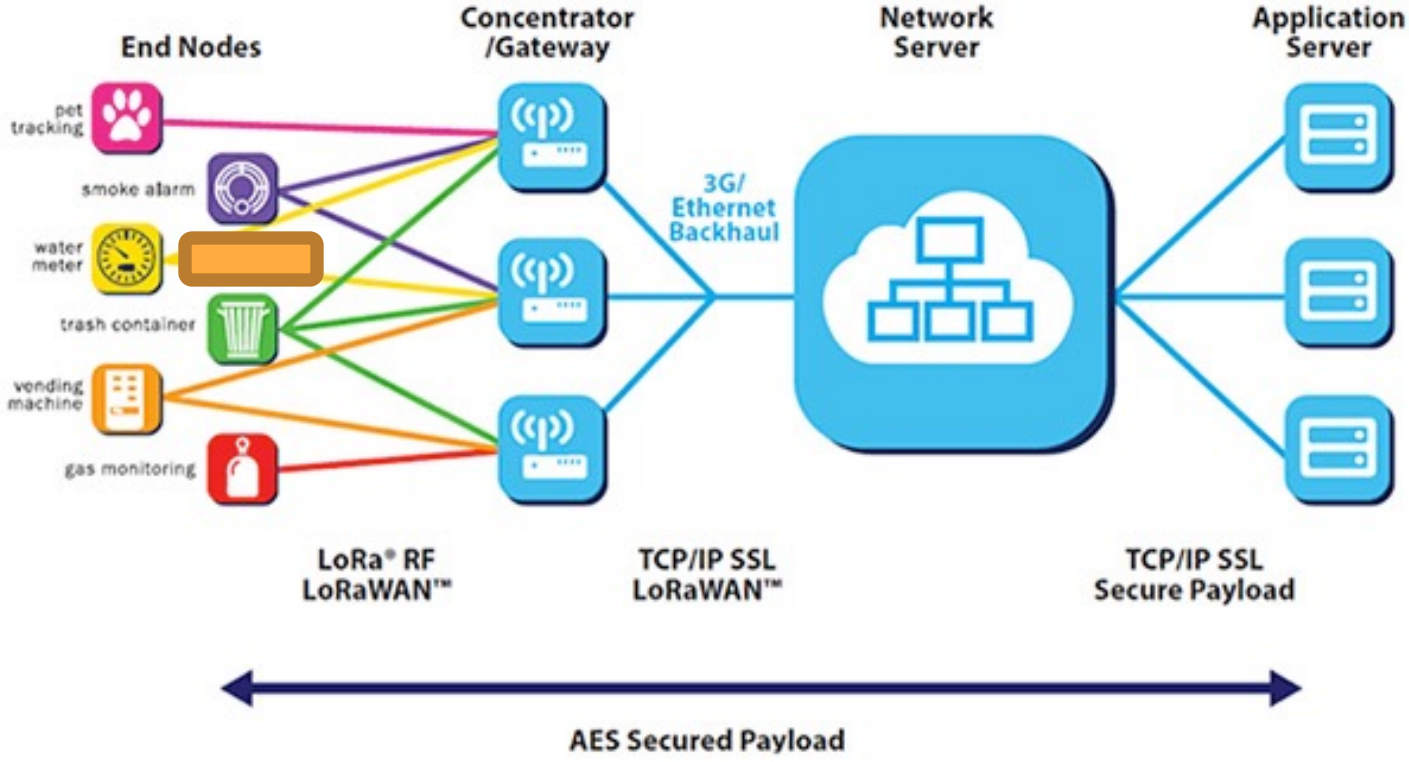
123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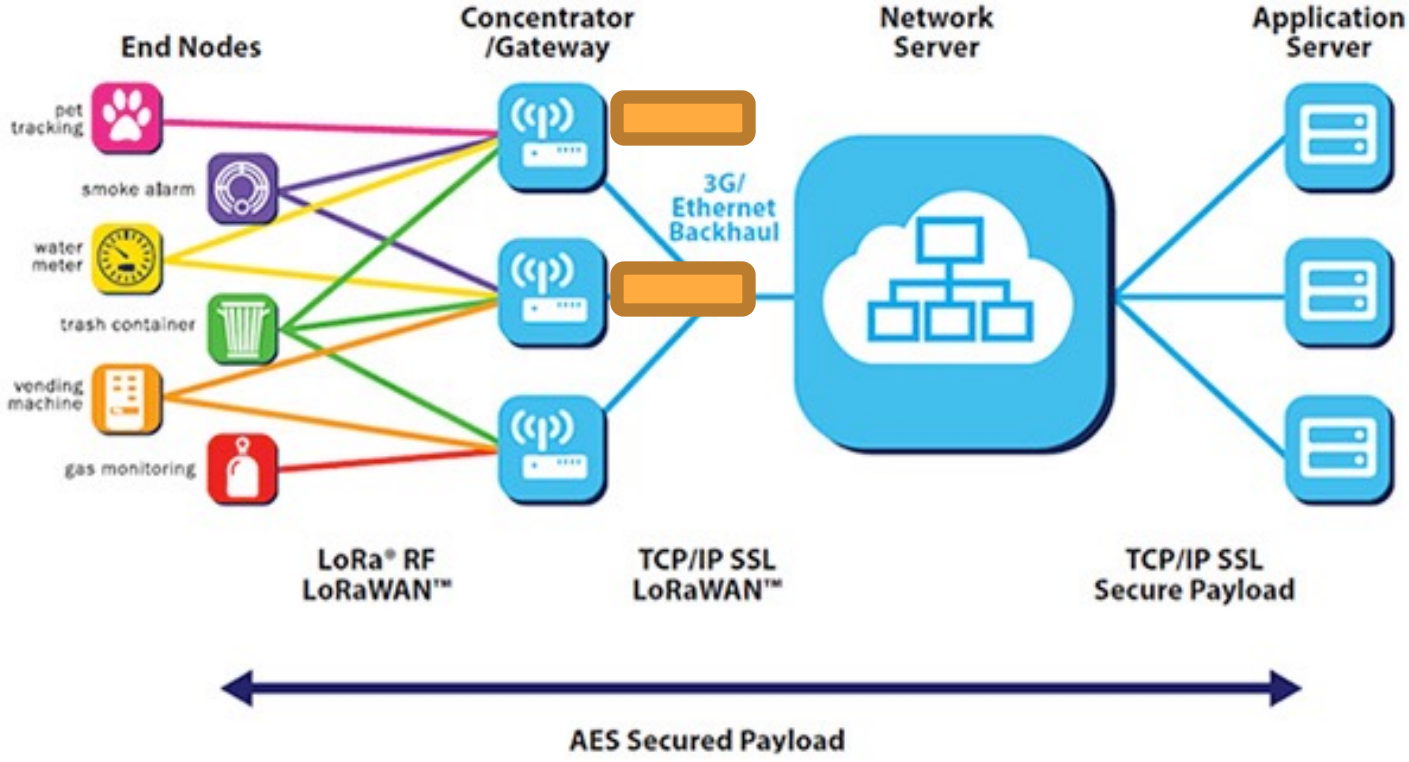
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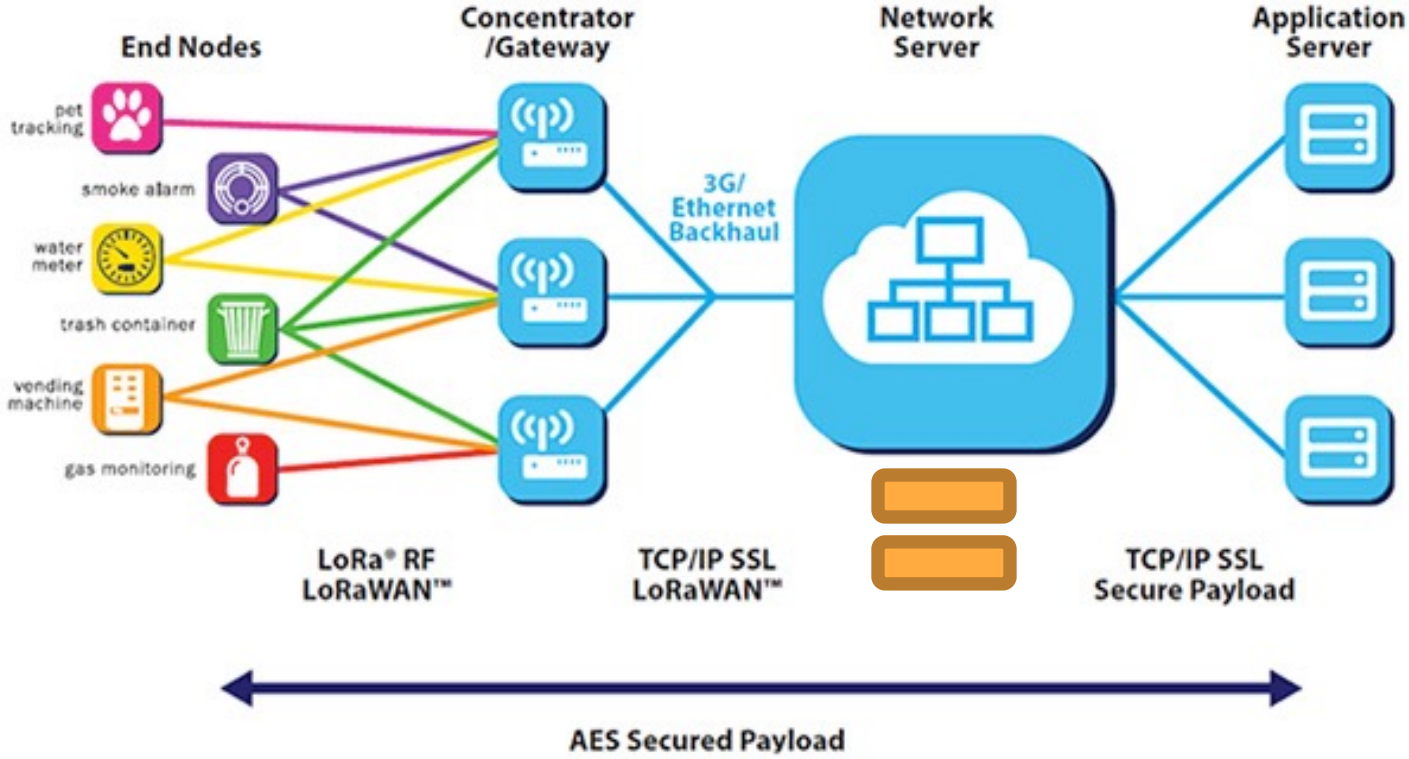
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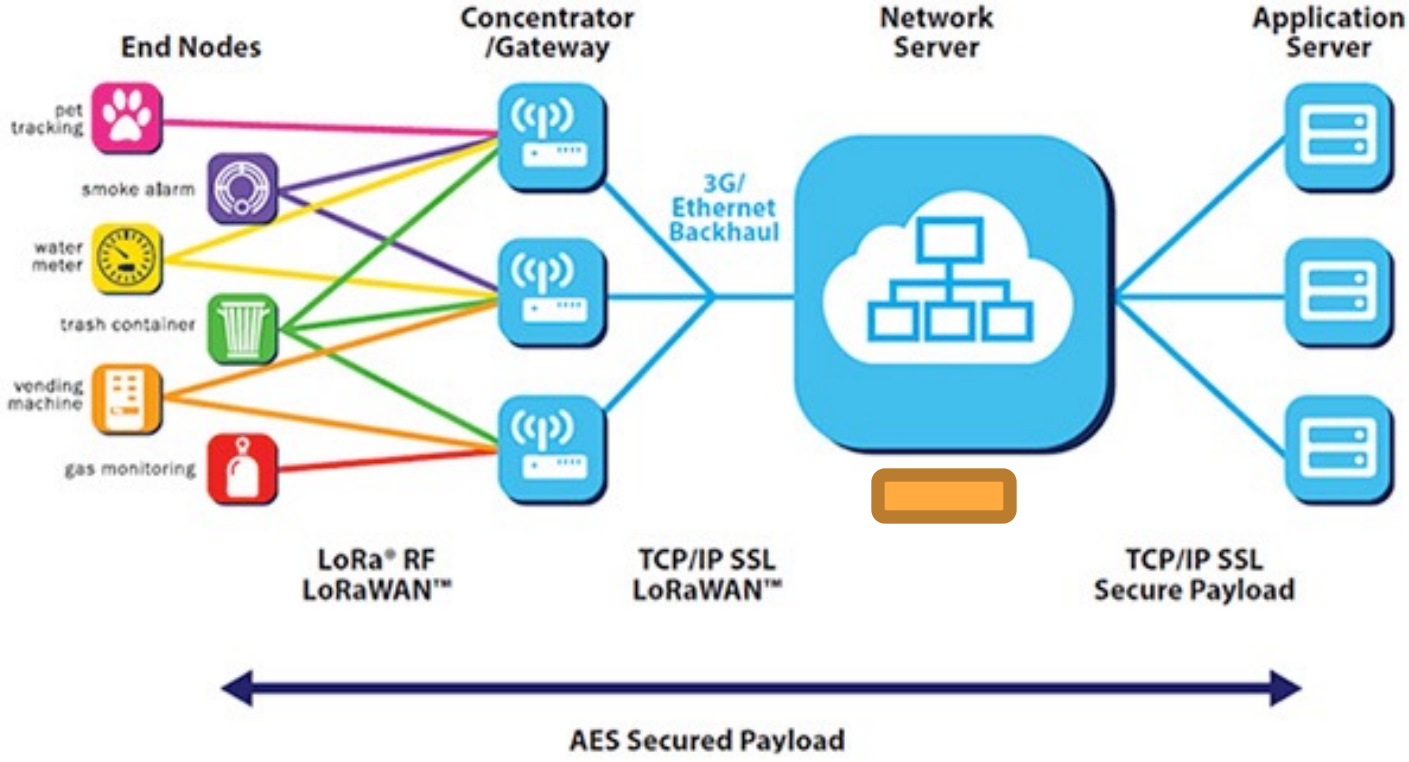
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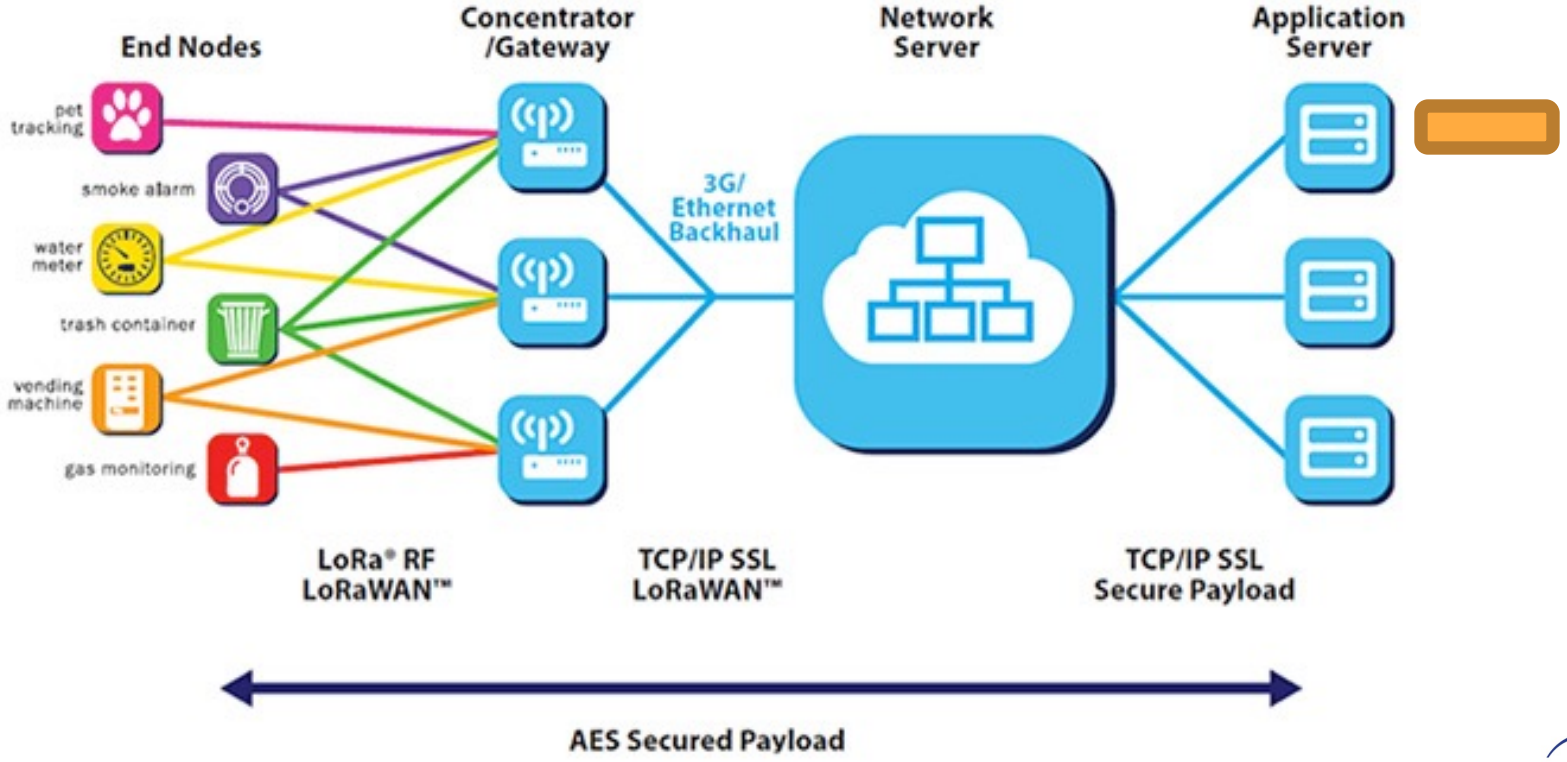
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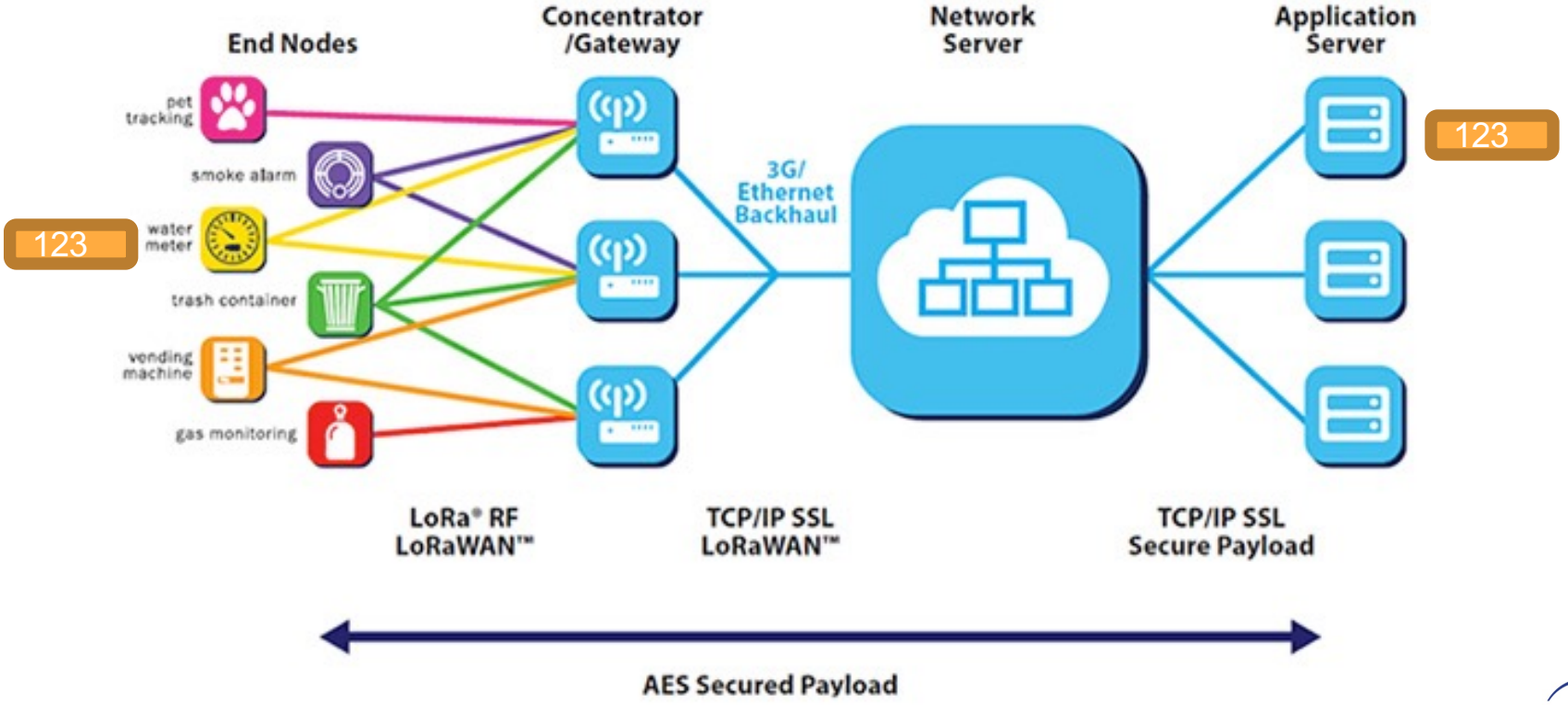
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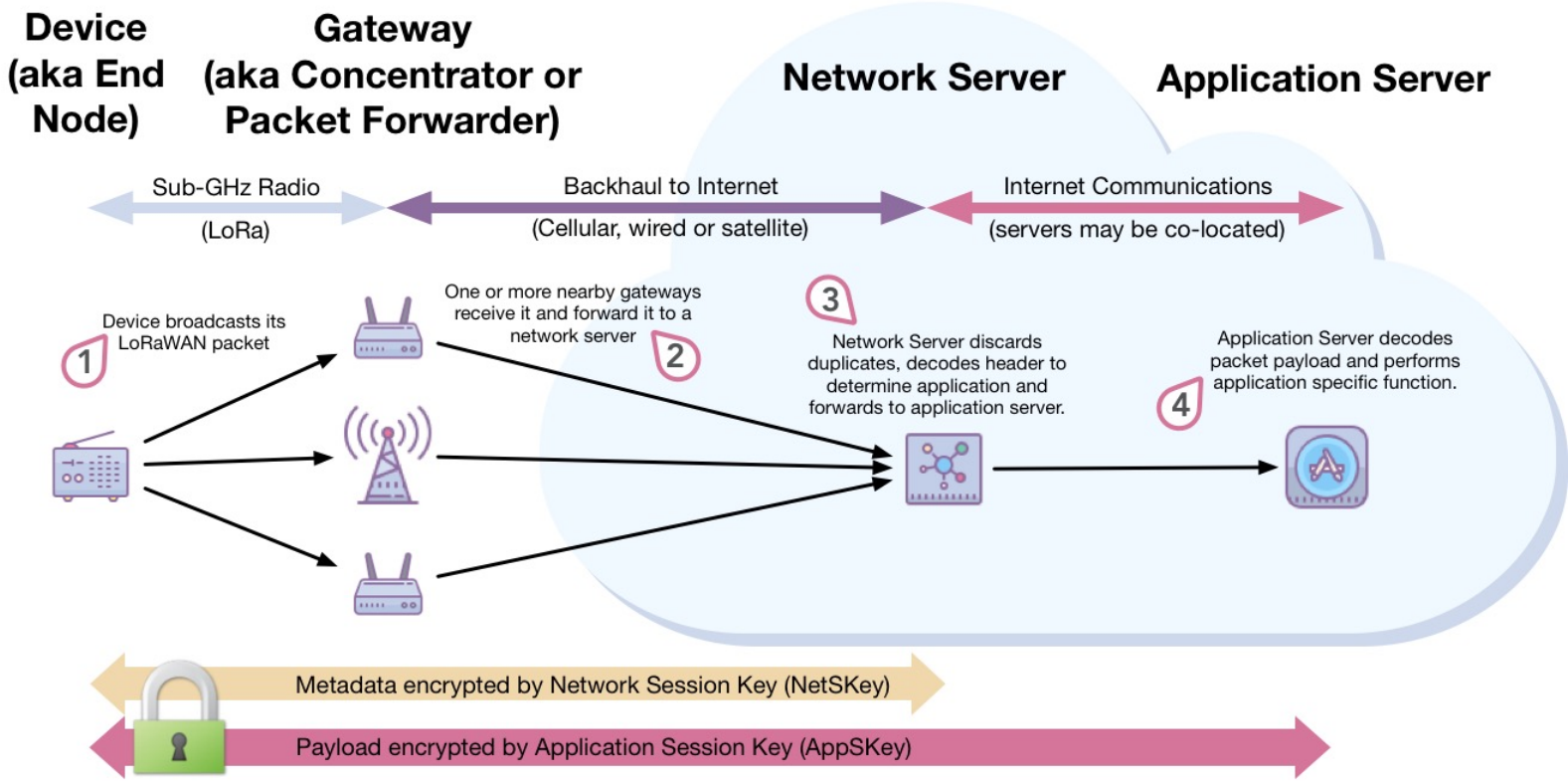
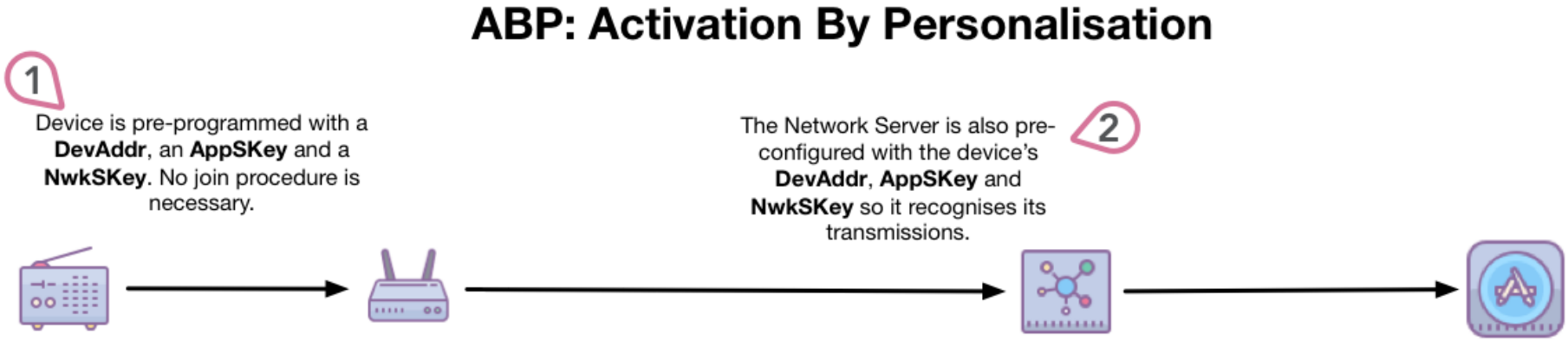
LoRaWAN architecture



LoRaWAN architecture



TTN

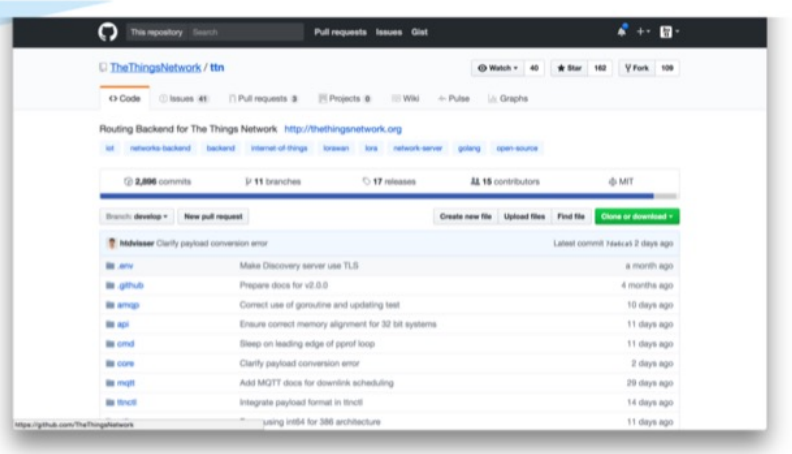
The Things Network Manifesto

Everything that carries power will be connected to Internet eventually.

Controlling the network that makes this possible means controlling the world. ***We believe that this power should not be restricted to a few people, companies or nations. Instead this should be distributed over as many people as possible without the possibility to be taken away by anyone.*** We therefore founded "The Things Network".

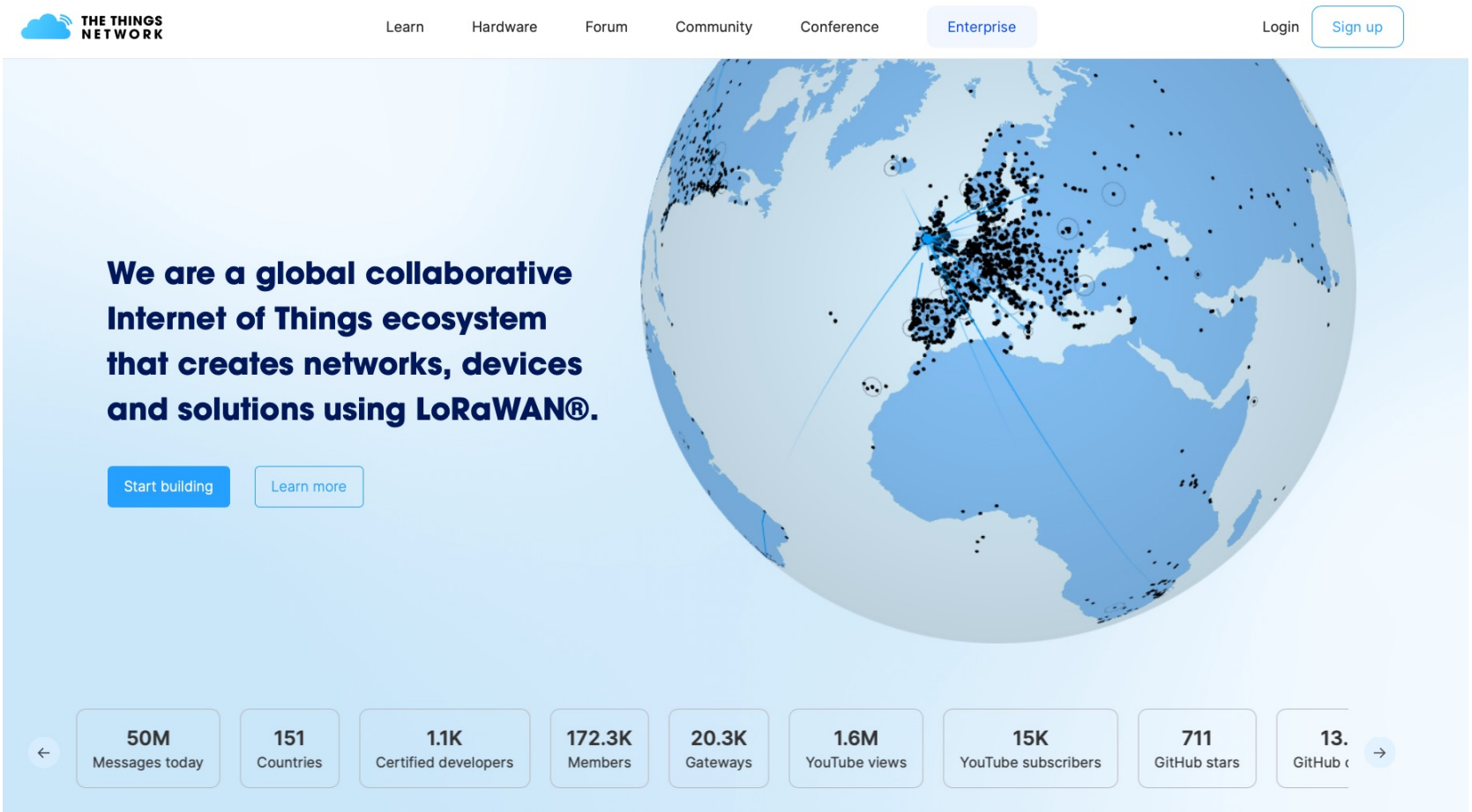
ICTP

TTN



OPEN SOURCE BACKEND

TTN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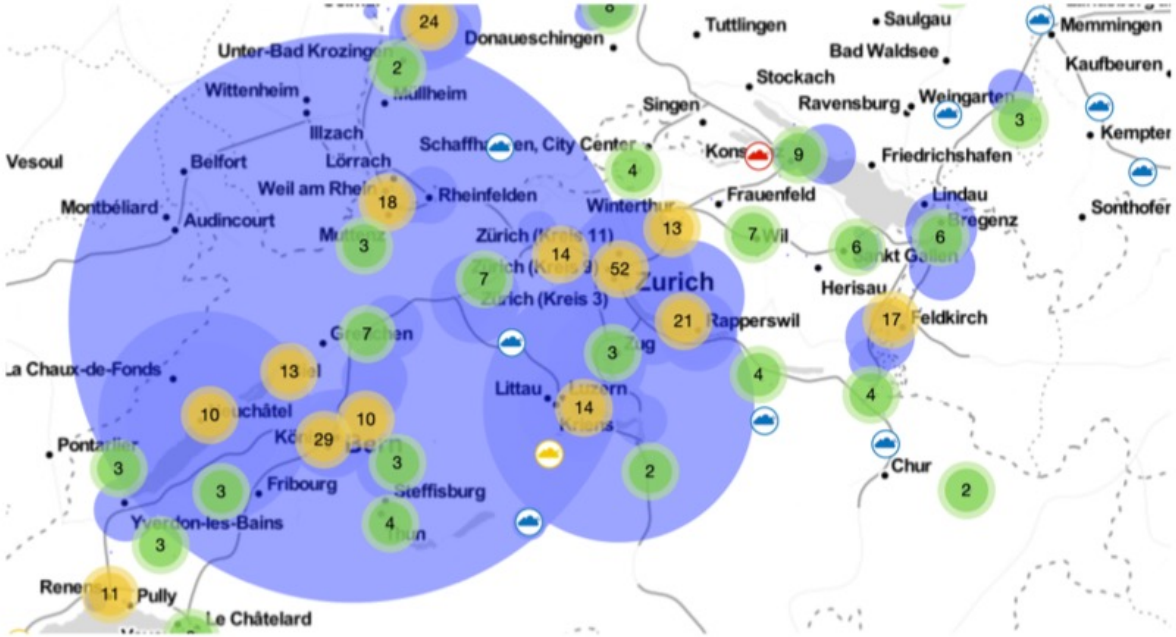
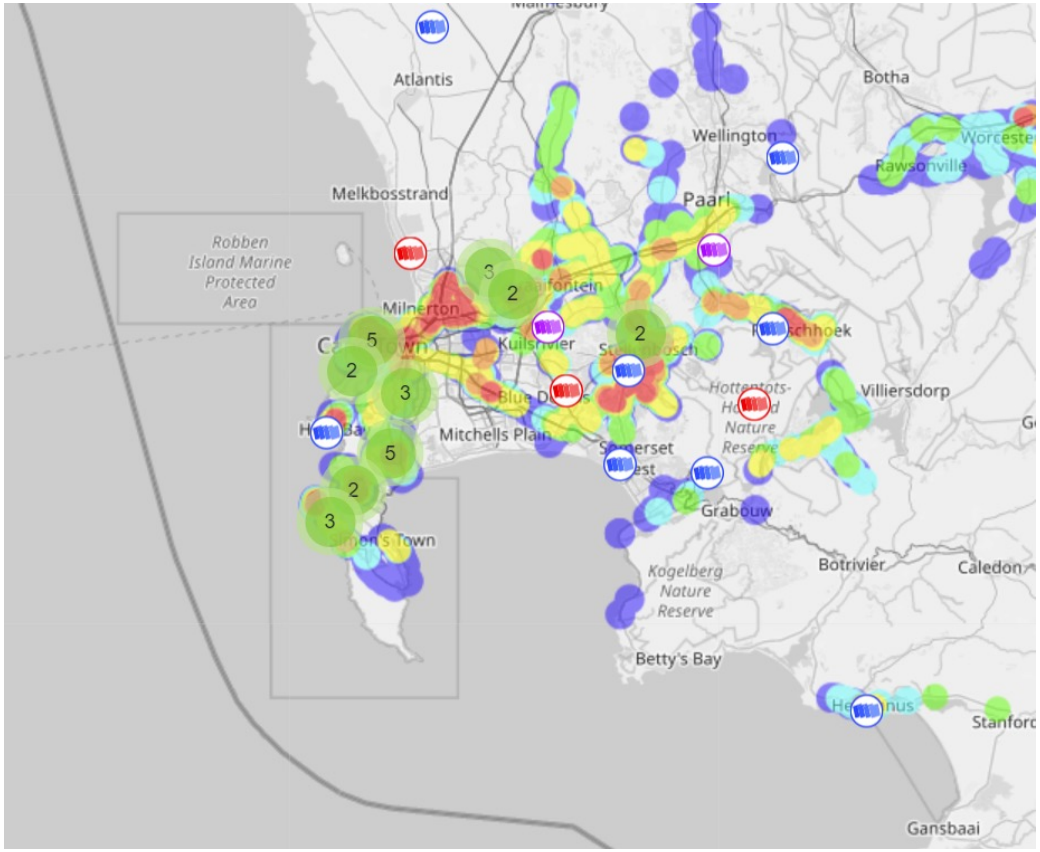
We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.
Start building
Learn more
50M
Messages today
151
Countries
1.1K
Certified developers
172.3K
Members
20.3K
Gateways
1.6M
YouTube views
15K
YouTube subscribers
711
GitHub stars
13.

TTN



https://ttnmapper.org

TTN

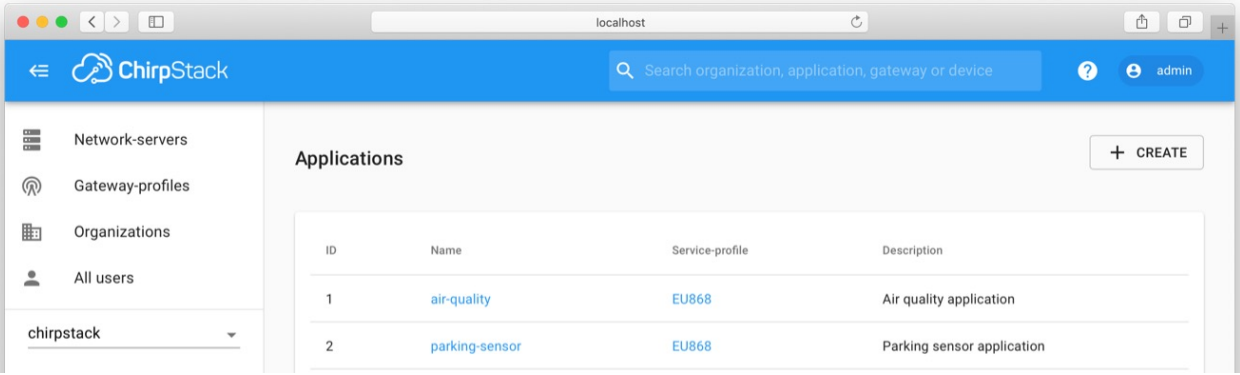

Atlantis
Botha
Wellington
Melkbosstrand
Paarl
Robben
Island Marine
Protected
Area
Milnerton
Kuilsrivier
Villiersdorp
Hottentots-
Holland
Nature
Reserve
Mitchells Plain
Somerset
West
Grabouw
Botrivier
Caledon
Kogelberg
Nature
Reserve
Betty's Bay
Gansbaai

Chirpstack

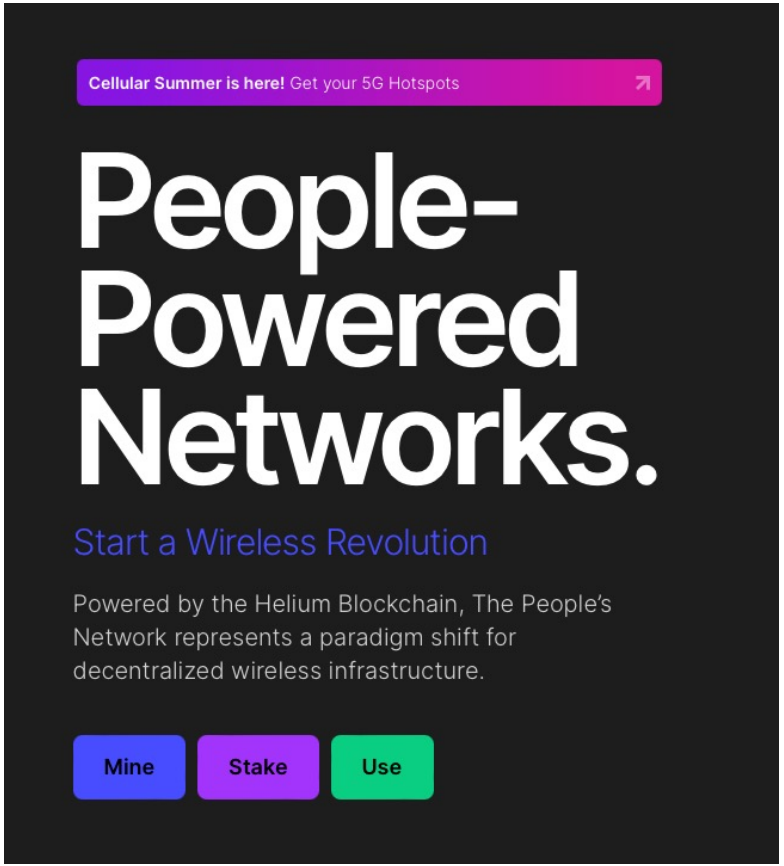
ChirpStack, open-source LoRaWAN® Network Server stack

The ChirpStack open-source LoRaWAN Network Server stack provides open-source components for LoRaWAN networks. Together they form a ready-to-use solution including an user-friendly web-interface for device management and APIs for integration. The modular architecture makes it possible to integrate within existing infrastructures. All components are licensed under the MIT license and can be used for commercial purposes.

Get started



Helium


Cellular Summer is here! Get your 5G Hotspots
People-Powered Networks.
Start a Wireless Revolution
Powered by the Helium Blockchain, The People's Network represents a paradigm shift for decentralized wireless infrastructure.
Mine
Stake
Use

LoRaWAN products

LoRaWAN Certified℠ Products

A huge array of certified products available now to fulfill the wide-ranging spectrum of IoT use cases served by LoRaWAN™.

Soon this will be extended to include LoRa Alliance™ member services, software and full solutions in addition to these certified devices. This will be a comprehensive directory of all our Members' products and services with tools to find the right solution for every LPWAN requirement.

ED1608

1M2M

1M2M's ED1608 is an out of the box, ready to use universal Low Power WAN Smart Sensor/GPS Tracker. It has on board 3D accelerometer,

ED1608 Rail Temperature Sensor

1M2M

The ED1608RTS is a rail temperature sensor that can be used to measure the temperature

Feedback?

Email me mzennaro@ictp.it