

IoT y Edge Computing: Historias de una relación necesaria

Pietro Manzoni

- Universitat Politècnica de València (UPV)
- Valencia - SPAIN
- pmanzoni@disca.upv.es

<http://grc.webs.upv.es/>



The GRC logo consists of a blue circle with the letters 'GRC' inside. To its right, the text 'GRUPO DE REDES DE COMPUTADORES' is written in a smaller font. Below the logo is a horizontal navigation bar with the following links: Home, Members, Papers, Projects, Teaching, Software, and Internal.

The Networking Research Group (GRC - Grupo de Redes de Computadores) of the Universitat Politècnica de València (UPV) was founded in 2000 and it is mainly composed of researchers of the Computer Engineering Department (DISCA). It keeps strong bonds and collaborations with other researchers in the same area in Spain and in the rest of the world.

The group research efforts are focused on offering Data Communication Solutions for Mobile Systems. The main areas of application are:

- AIoT infrastructures for environmental sustainability
- Drone-based networks
- Efficient IoT infrastructures development
- Intelligent Transport Systems
- LPWAN-based networks
- Mobile edge computing
- Pub/Sub systems
- Social sensing



Infos and News:

- [Overview of GRC research \[Sept. 2021\]](#)
- [GRC YouTube channel](#)
- [COVIDsensing: a tool to analize COVID spreading using AI](#)

Events and CfPs:

Conferences:

- [GoodIT](#), International Conference on Information Technology for Social Good, September 7-9, 2022, Limassol (CYPRUS).
- [NET4us](#), Workshop on Networked sensing systems for a sustainable society, during SIGCOMM 2022, August 22-26, 2022, Amsterdam (Netherlands).

Journals Special Issues:

- Computer Networks, Elsevier, Special Issue on "[Pub/sub solutions for interoperable and dynamic IoT systems](#)". Submission deadline: to be opened soon.
- Frontiers, Loop, Research Topic on "[SDN migration challenges and practices in ISP/Telcos' Networks](#)". Submission deadline: open.
- ITU Journal, ITU, Special issue on "[Network virtualization, slicing, orchestration, fog and edge](#)

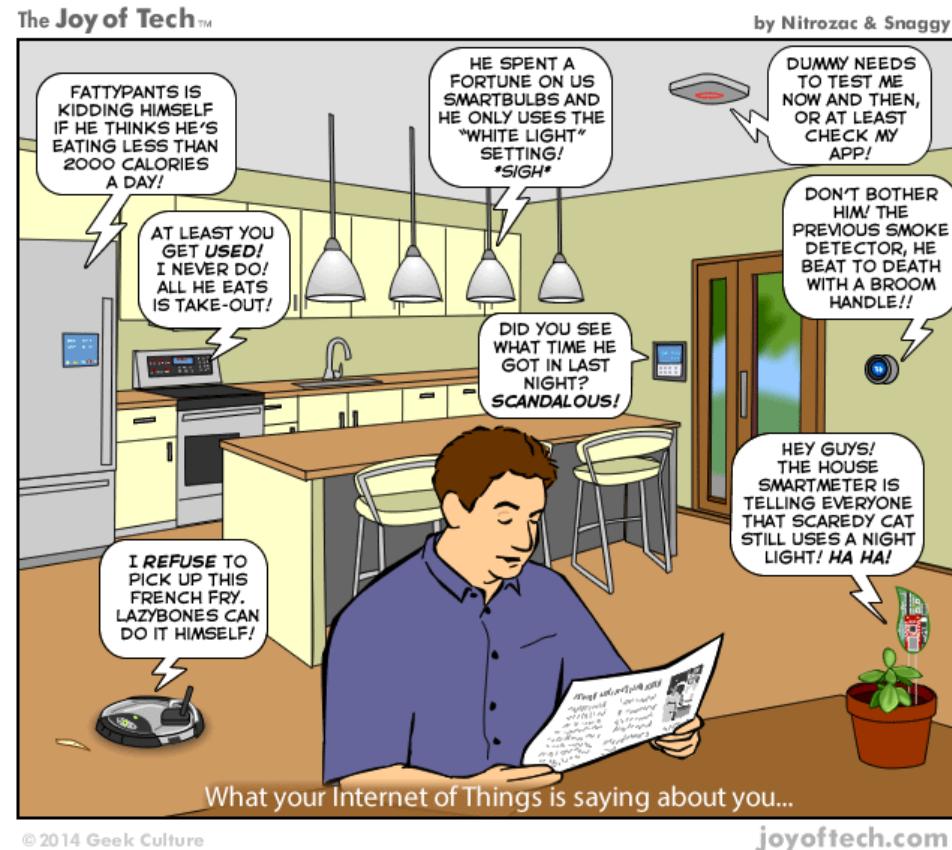
- **Jueves 7 de abril 2022**
 - 10:00 – 11:30 Seminario técnico (Teoría)
 - “A brief introduction to IoT, LoRaWAN, and MQTT”
 - 15:30 – 17:30 Seminario técnico (Laboratorio)
 - LoRaWAN and MQTT hands-on examples
- **Viernes 8 de abril 2022**
 - 10:00 – 11:30 Seminario técnico (Teoría)
 - “A brief introduction to TinyML”
 - TinyML hands-on examples: TensorFlow Lite Micro
 - 12:00 – 13:30 Seminario técnico (Laboratorio)
 - TinyML hands-on examples: Edge Impulse

A *brief introduction to IoT*

Internet of Things (IoT)

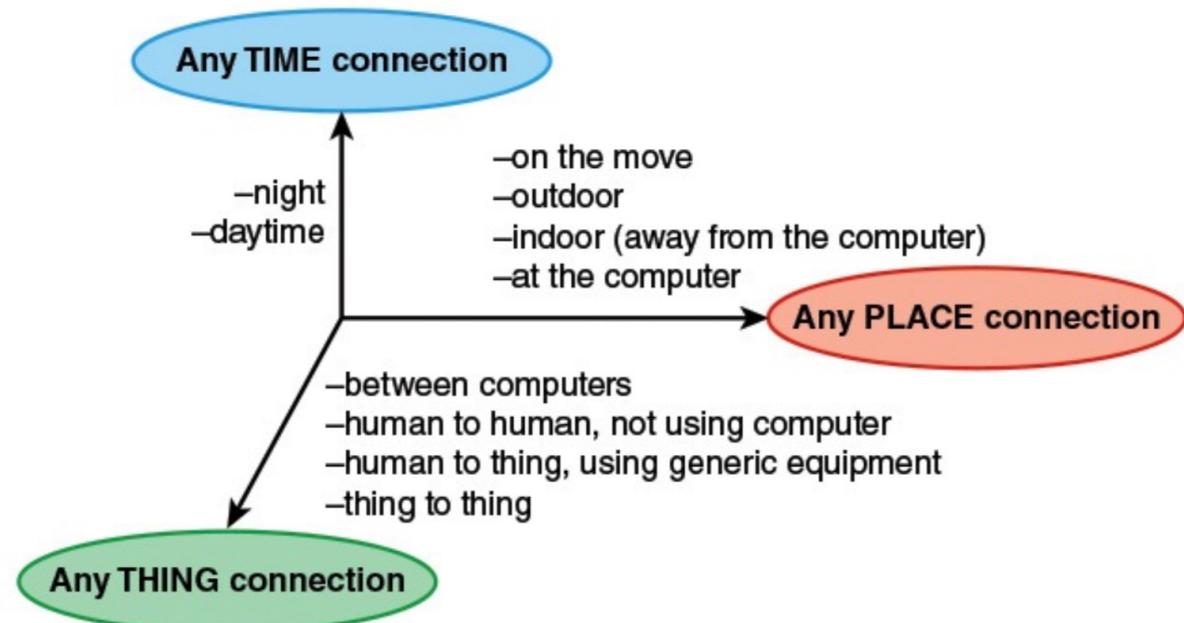
A quick and “physical” definition:

“A network of items—each embedded with sensors—which are connected to the Internet.”



Internet of Things (IoT): a more formal definition

“The IoT can be viewed as a **global infrastructure** for the information society, **enabling advanced services by interconnecting (physical and virtual) things** based on existing and evolving interoperable information and communication technologies (ICT).”

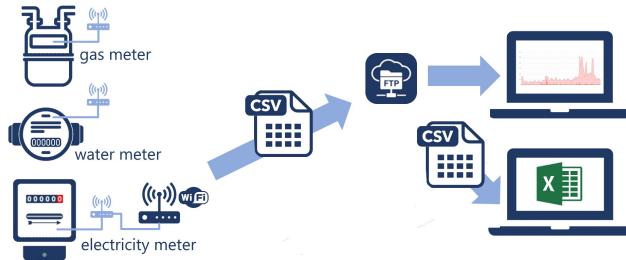


Source: Recommendation ITU-T Y.2060

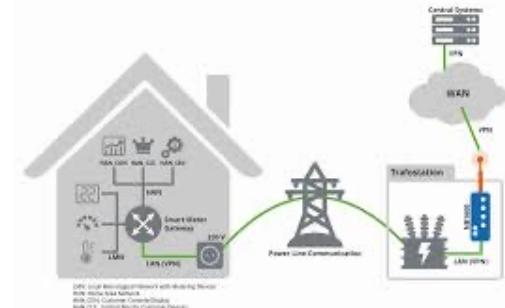


UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

- The Machine-to-Machine Architecture model proposed by ETSI is considered a predecessor of IoT
- M2M was meant for automated interactions between devices



Smart metering

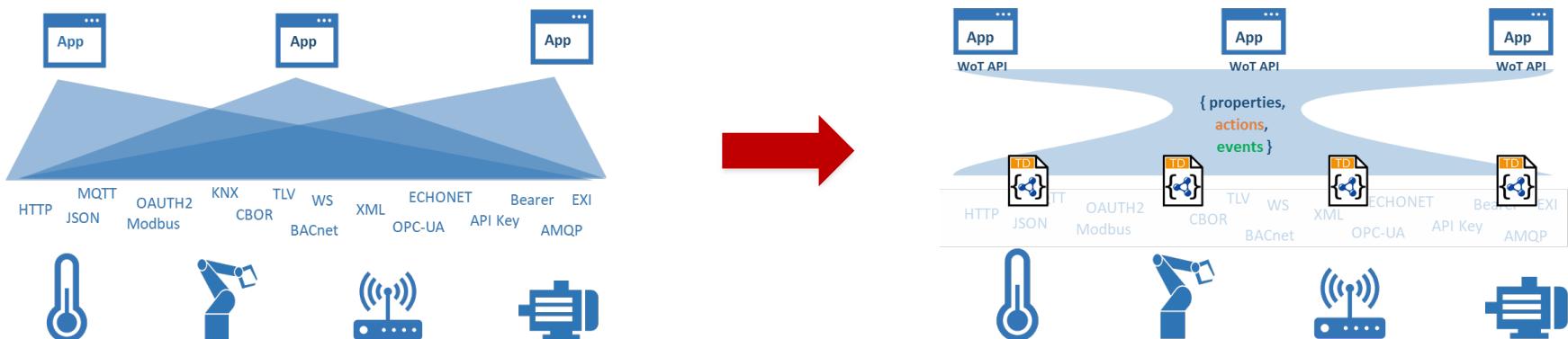


- Currently M2M and IoT are used interchangeably
 - <https://www.etsi.org/technologies/internet-of-things>
- Basic committees
 - <https://www.etsi.org/committee/smартm2m>
 - <https://www.etsi.org/committee/onem2m>



<https://www.w3.org/WoT/>

- "The Web of Things (WoT) is a term used to describe approaches, software architectural styles and programming patterns that allow real-world objects to be part of the World Wide Web."
- The Web of Things (WoT) tries to avoid the fragmentation of the IoT simplifying integration across IoT platforms and application domains by using and extending existing, standardized Web technologies.
- From the developer's perspective, the WoT enables access and control over IoT resources and applications using mainstream web technologies (such as **HTML 5.0, JavaScript, Ajax, PHP, Ruby n Rails**, etc)
- The approach to building WoT is therefore based on RESTful principles and REST API s, which enable s both developers and deployers to benefit from the popularity and maturity of web technologies.



All big companies are active in this area



<https://iot.telefonica.com/en/>



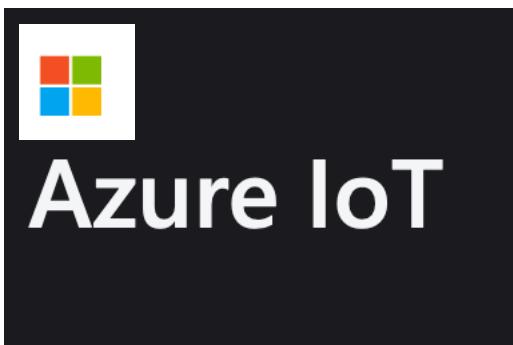
<https://www.cisco.com/c/en/us/solutions/internet-of-things/overview.html>



<https://cloud.google.com/solutions/iot/>

Internet of Things
on IBM Cloud

<https://www.ibm.com/cloud/internet-of-things>



<https://azure.microsoft.com/es-es/overview/iot/#overview>

SAMSUNG
SmartThings

<https://www.samsung.com/cl/smartthings/>

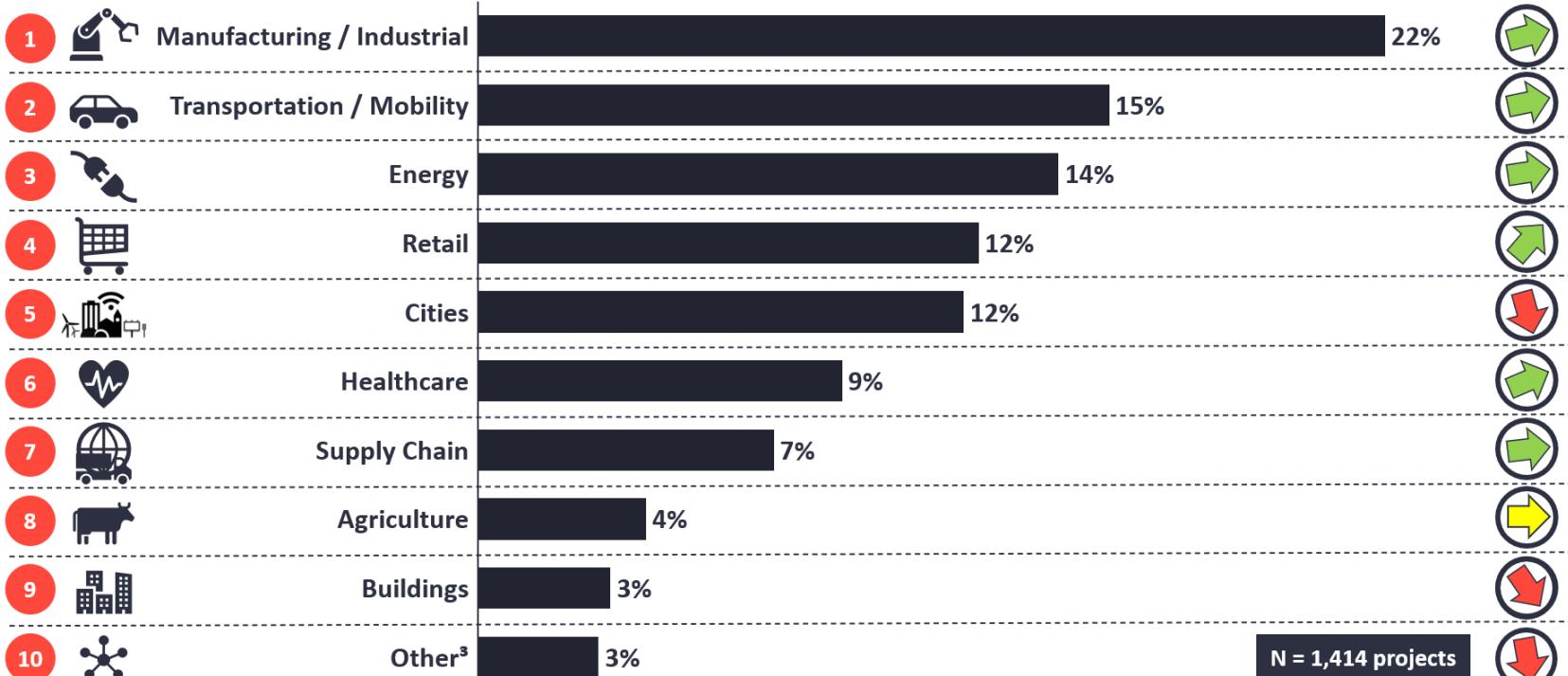


UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA



Insights that empower you to understand IoT markets

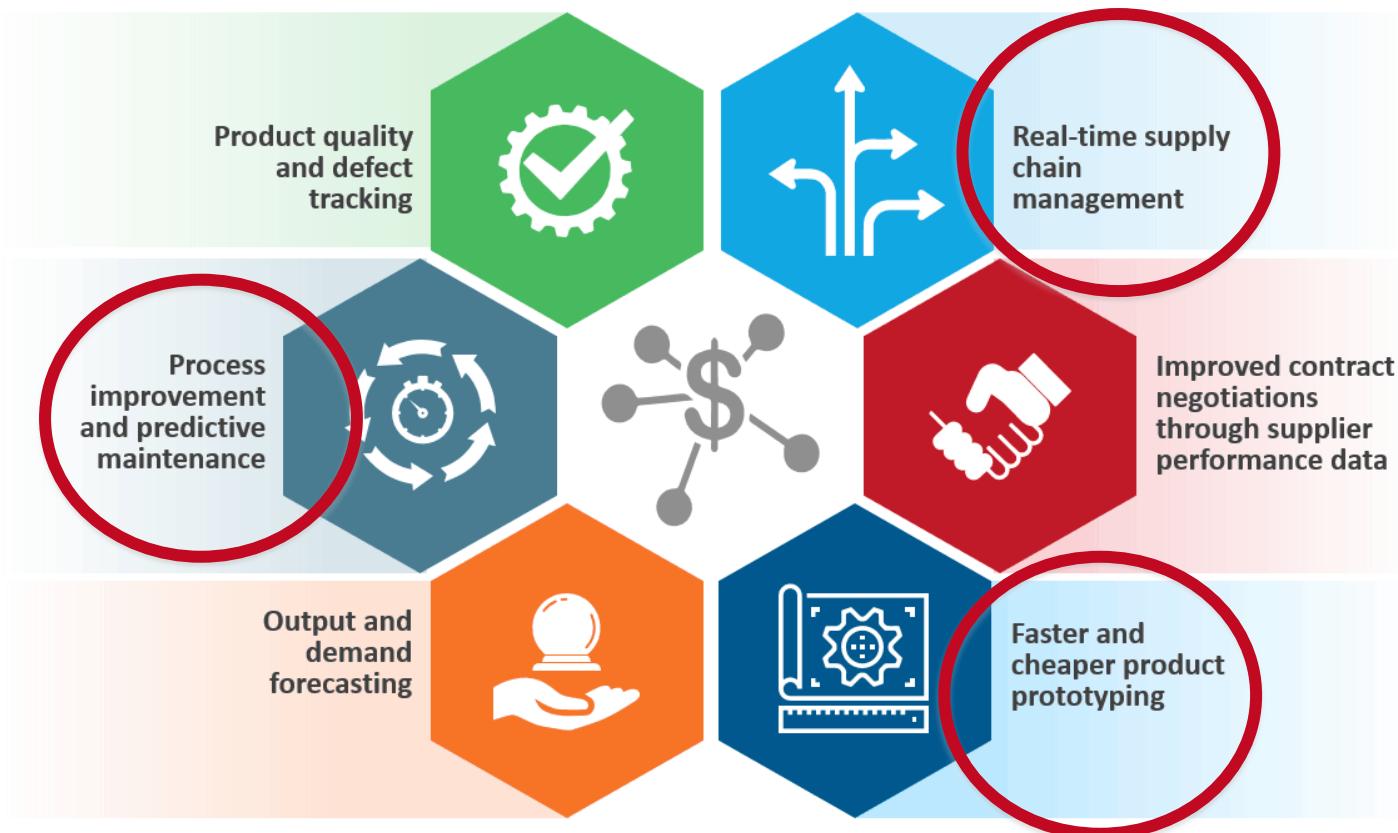
Top 10 IoT Application areas 2020

Global share of Enterprise IoT projects¹

Note: 1. Based on 1,414 publicly known IoT projects (not including consumer IoT projects eg smart home, wearables, etc.) 2. Trend based on relative comparison with % of projects in the 2018 IoT Analytics IoT project list e.g., a downward arrow means the relative share of all projects has declined, not the overall number of projects. 3. Other includes IoT projects from Enterprise & Finance sectors. Source: IoT Analytics Research - July 2020

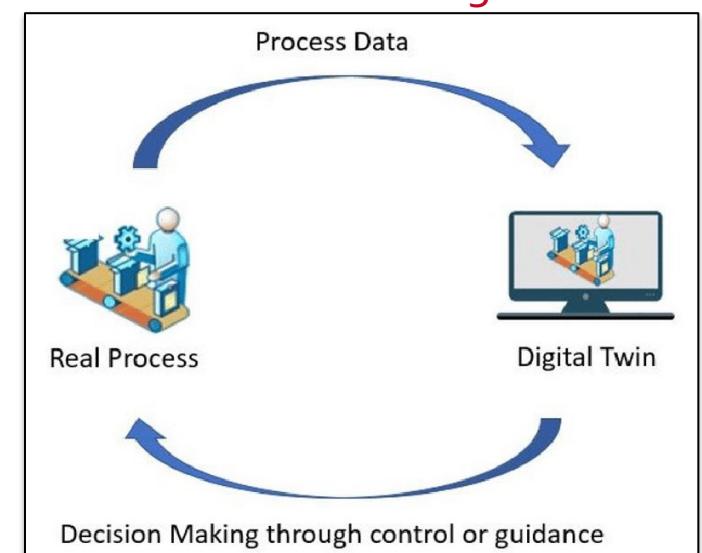
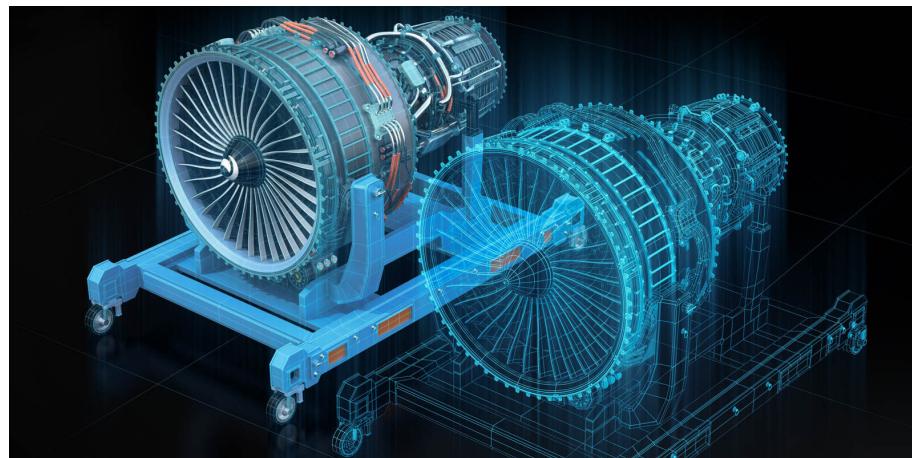
How Industry 4.0 is Helping Manufacturers

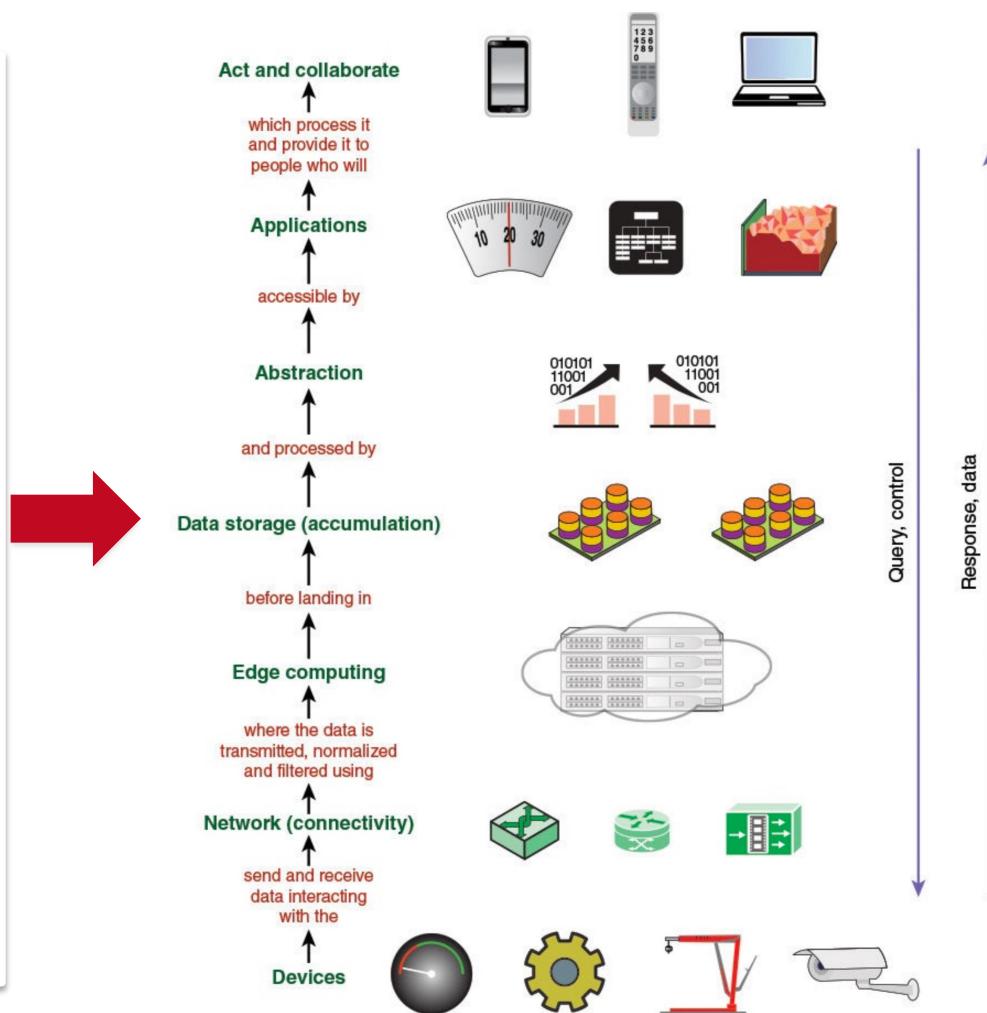
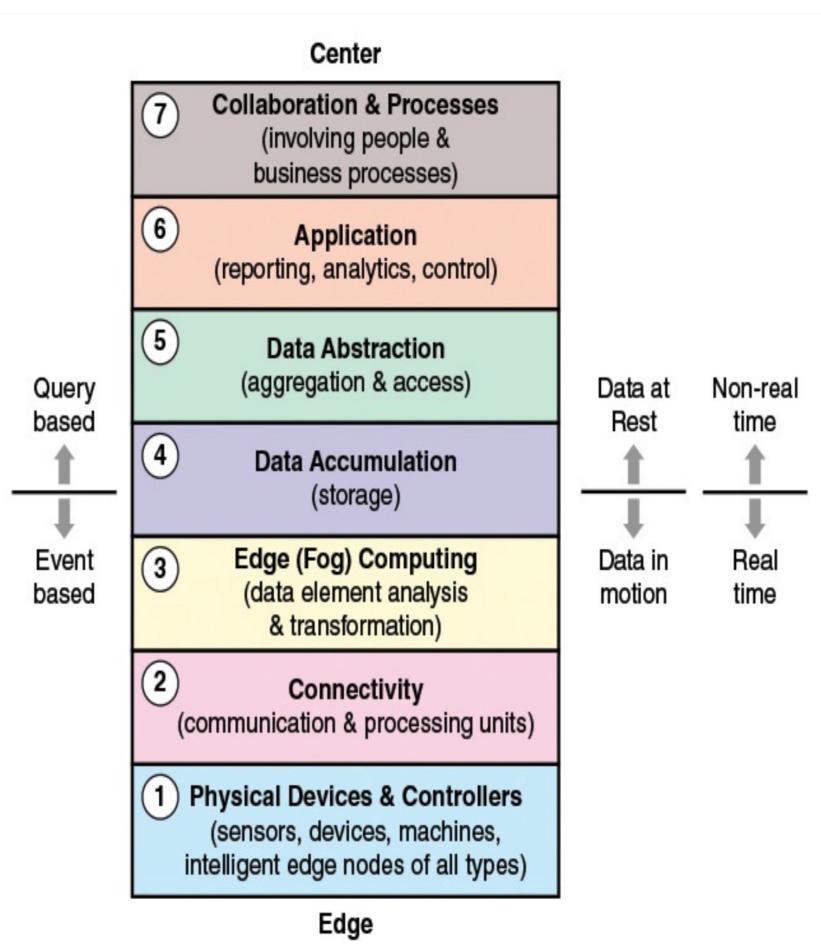
Industry 4.0 – automation and data exchange in manufacturing technologies – is helping manufacturers to achieve their goals of reducing cost and increasing profitability through improvements and optimization across the value chain



Everest Group® Enterprise Digital Adoption in Manufacturing | Pinnacle Model™ Assessment 2018

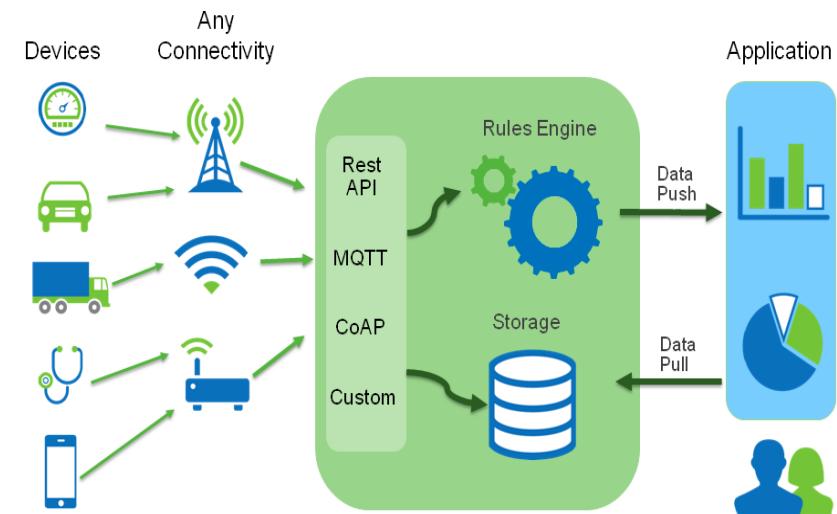
- **Rolls-Royce TotalCare**, "engine as a service".
 - Predictive maintenance (**know what will break**).
 - Anomaly detection (**find unknown issues**).
 - Live feedback (**from deployed engines**).



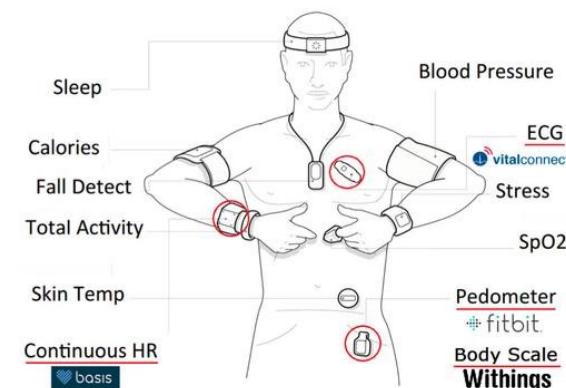


Simplified model

- Devices (“things”)
 - These could be sensors, actuators, robots, cars, whatever can be connected.
 - A lot of inheritance from the world of “sensors networks”
- Connectivity
 - To connect things reliably to Internet.
 - Wireless connectivity is central to this task
- Platform
 - the collected data needs to be stored and processed somewhere. Typically cloud-based infrastructures

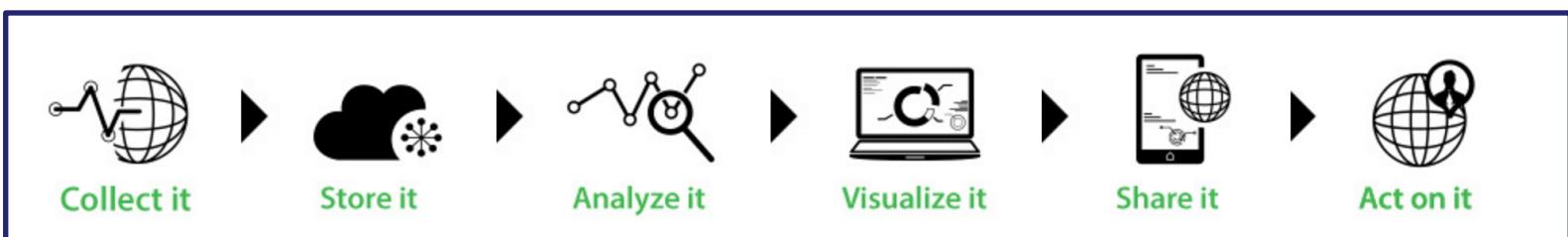


Examples of Things



thing: With regard to the Internet of things, this is an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks.

- Microsoft Azure IoT Hub
- Amazon AWS IoT
- Google Cloud IoT
- Oracle Internet of Things (IoT) Cloud Service
- Cisco IoT Solutions
- IBM Watson IoT Platform
- ...
- FIWARE
- ThingSpeak
 - Based on MATLAB
- ThingsBoard
- GroveStreams
- SensorCloud
- ...

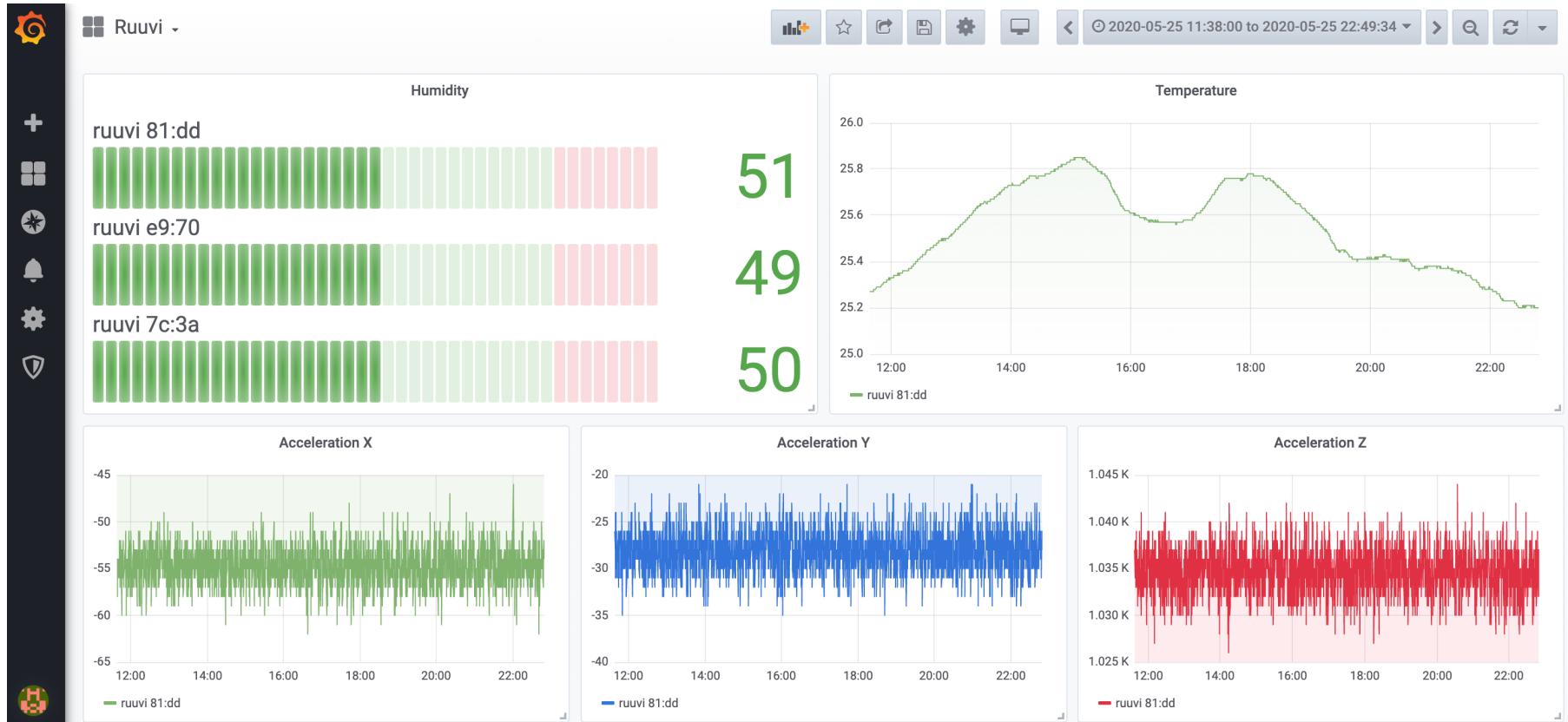


The screenshot shows a laptop displaying the Ubidots IoT platform. The dashboard is titled 'Clean Air Tank' and features several data visualization components:

- Metrics:** Tank Level (76.80%), Pressure (4,880 ps), and Temperature (66.30%).
- Graphs:** A circular gauge showing Tank Volume (83.3) and a line graph showing Tank Volume over time.
- Controls:** A valve status indicator (Closed) and a valve control button.
- Thresholds:** Sliders for Pressure Threshold (5.300) and Volume Threshold (89).
- Pressure Control:** A gauge showing Pressure (psl) at 4,880.00 ps with a control slider at 6,000.

The Ubidots header includes links for ABOUT, INDUSTRIES, IOT ECOSYSTEM, PLATFORM, PRICING, and RESOURCES, along with a 'GO TO DASHBOARD' button.

Data visualization & analytics: an example



HTTP (REST, CoAP), MQTT, ...

TCP, UDP

IPv4, IPv6, 6LoWPAN

Ethernet

WiFi

ZigBee, Bluetooth
LE, UWB, RFID, ...

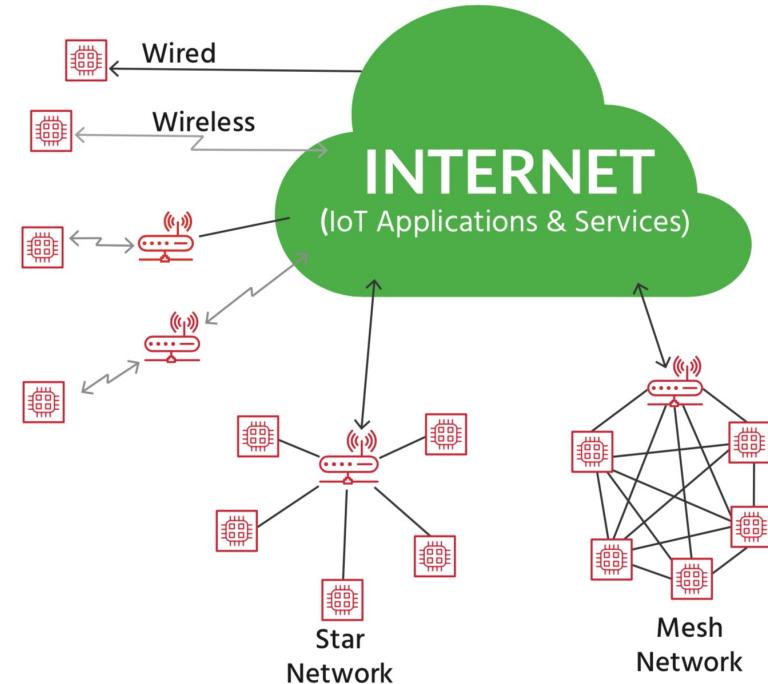
2G: GPRS;
4G: LTE Cat M1
(eMTC)
LTE Cat NB1 (NB-IoT)

LoRaWAN,
SIGFOX

The 4 communication models

Internet Architecture Board (IAB) released (2015) a guiding architectural document for networking of smart objects (**RFC 7452**) which outlines a framework of four common communication models used by IoT devices.

1. Device-to-Device
 2. Device-to-Cloud
 3. Device-to-Gateway
 4. Back-End Data Sharing
- It is possible that more than one pattern can be applied at the same time in a product.



Device-to-Device Communication Pattern



Ellipse

★★★★★ See all reviews

A smart bike lock that connects to your phone to provide keyless entry, theft detection, bike sharing, crash alerts and more.

Quantity

- 1 +

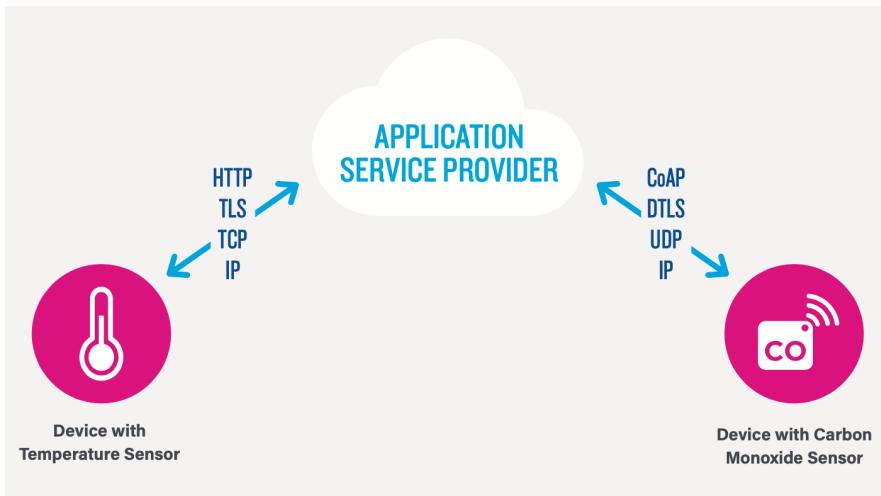
\$199

BUY NOW

Free shipping to the U.S.
International shipping starts at \$20.



Device-to-Cloud Communication Pattern



BLOOM Home Control insecticida volador eléctrico líquido controlable desde el móvil aparato + 1 recambio

35,69 € (35,69 € / Unidad)

UNIDADES
- 1 +

AÑADIR AL CARRO

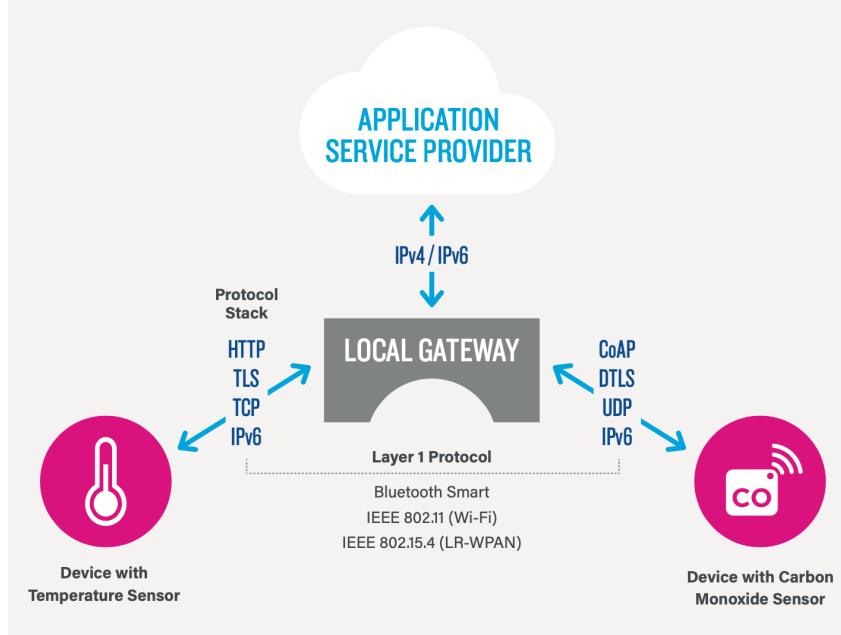
Información general

- Bloom Home Control es un insecticida eléctrico líquido con la fórmula más avanzada para protegerte a ti y a tu familia de los mosquitos común y tigre.
- Programable según tus necesidades.
 - Se conecta y controla a distancia a través de tu Smartphone (aplicación disponible para Android & iOS). Cuando lo necesites y desde donde quieras.
 - Control de la intensidad: Normal y Max.
 - Modo Inteligente: este modo ajustará la intensidad y duración de forma automática para ti dependiendo del tamaño de la habitación, hábitos de uso y la intensidad de mosquitos según AccuWeather.
 - Recordatorio para comprar un recambio. Recibe una notificación automática cuando el contenido líquido esté por debajo del 20%.

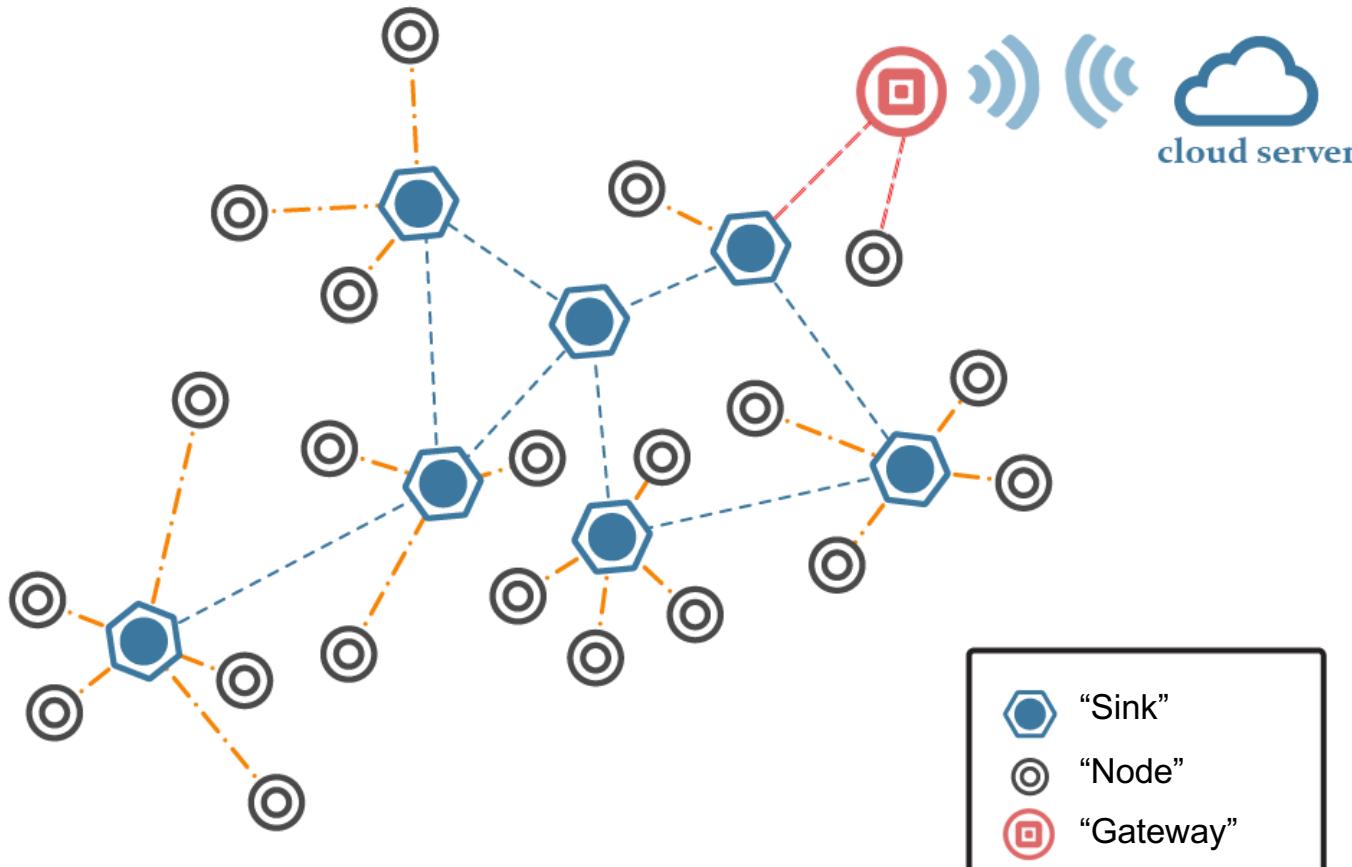


UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

Device-to-Gateway Communication Pattern

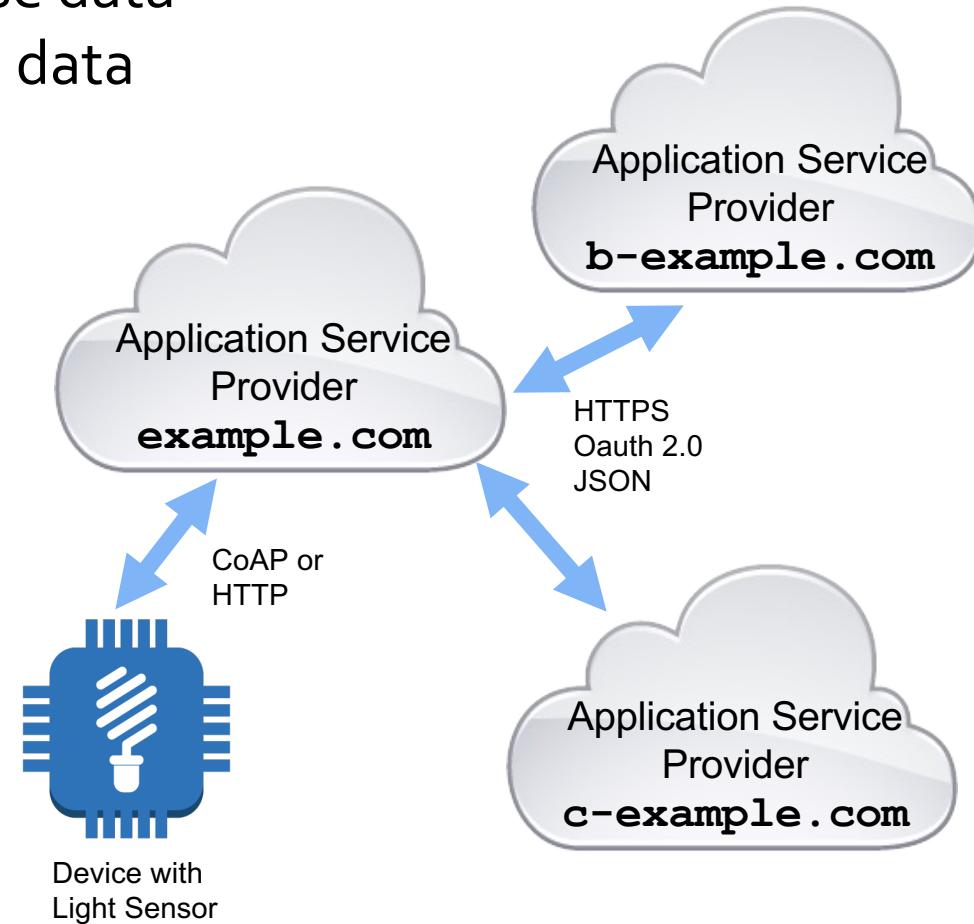


Device-to-Gateway: More complex configurations



Back-End Data Sharing

- Provides the possibility to export and to analyse data in combination with data from other sources.

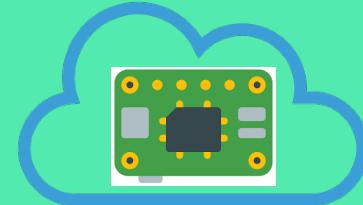


Edge computing

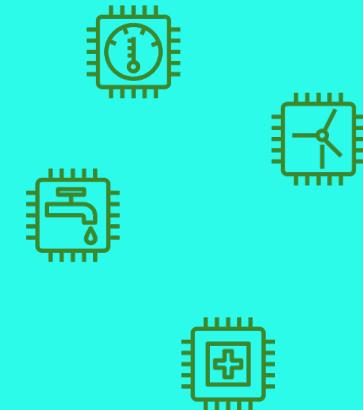
Core cloud

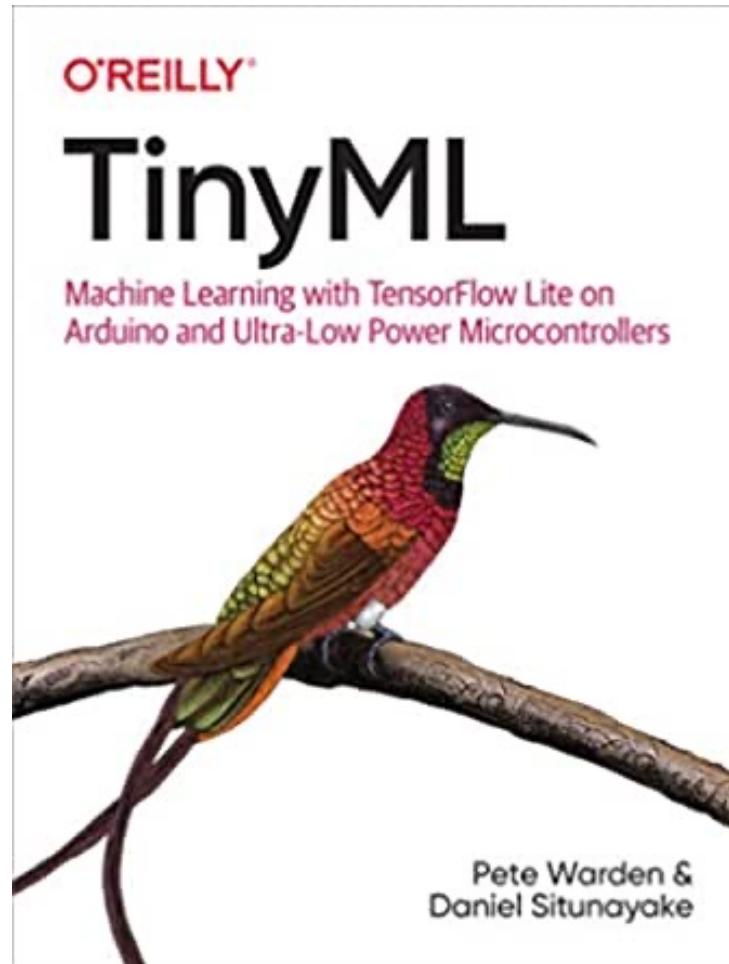


Edge Node



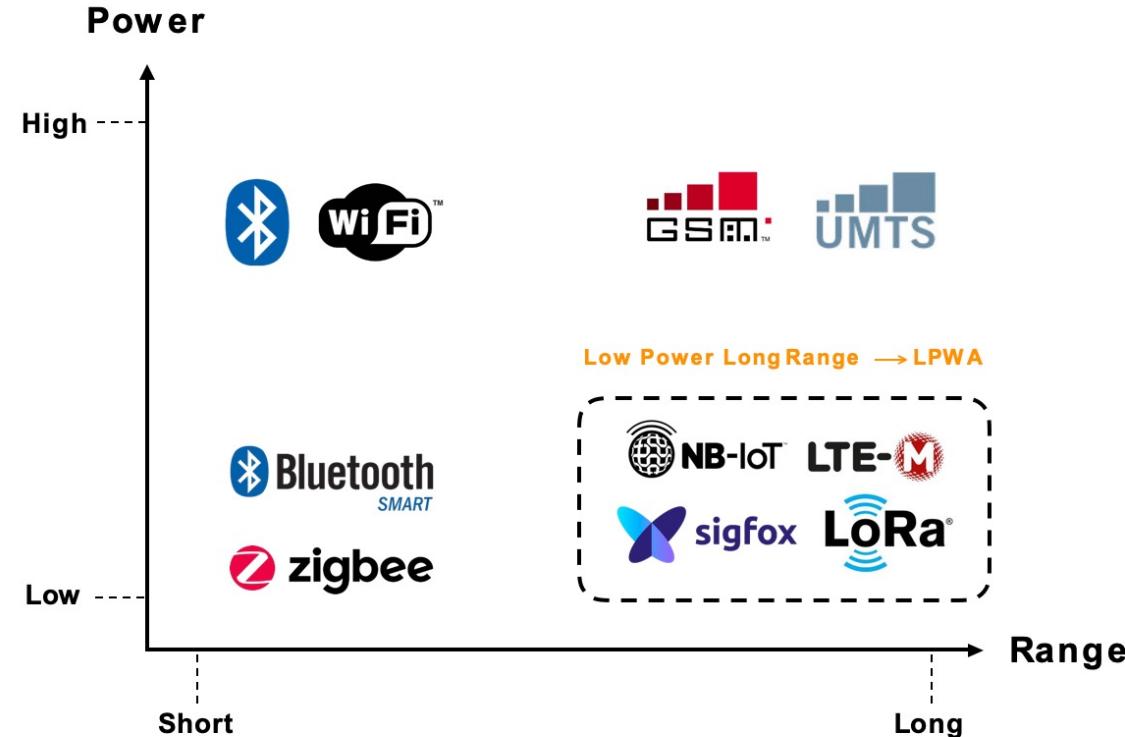
Edge devices





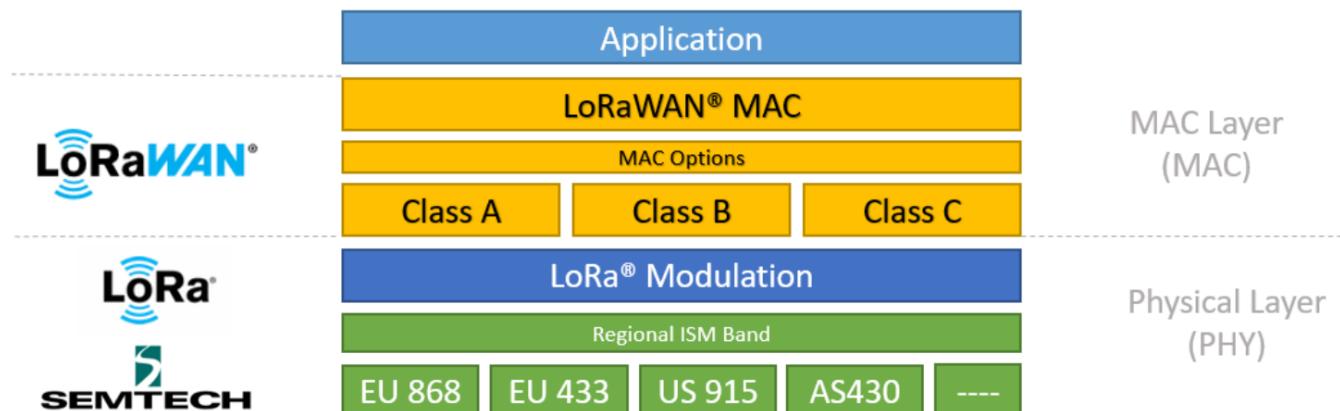
A brief introduction to LoRaWAN

LPWAN: range vs power



LoRaWAN: a sub-gigahertz wireless technology

- LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery-operated Things in a regional, national or global network
 - by Semtech Corporation (<http://www.semtech.com/>)
- LoRaWAN™ defines the communication protocol and system architecture for the network, while the LoRa physical layer enables the long-range communication link.



<https://lora-developers.semtech.com/library/tech-papers-and-guides/lora-and-lorawan/> ©

- The LoRa® Alliance is an open, non-profit association of members whose mission is:
 - “..promote and drive the success of the LoRaWAN® protocol as the leading open global standard for secure, carrier-grade IoT LPWAN connectivity...”
 - “To develop and promote LoRaWAN® technology and its ecosystem to deliver massive IoT”
- Specification is free to download:
 - <https://lora-alliance.org/resource-hub/lorawan-104-specification-package>



LoRaWAN® L2 1.0.4 Specification (TS001-1.0.4)

Authored by the LoRa Alliance Technical Committee

Technical Committee Chair and Vice-Chair:
A.YEGIN (Actility), O.SELLER (Semtech)

Editors:
T.KRAMP (Semtech), O.SELLER (Semtech)

Contributors (in alphabetical order):
A.BERTOLAUD (Gemalto), I.CALABRESE (A2A Smart City), J.CATALANO (Kerlink), J.DELCLEF (ST Microelectronics), V.DELPORT (Microchip Technology), P.DUFFY (Cisco), F.DYDUCH (Bouygues Telecom), T.EIRICH (Semtech), L.FERREIRA (Orange), Y.GAUDIN (Kerlink), S.GHAROUT (Orange), O.HERSENT (Actility), A.KASTTET (Birdz), D.KJENDAL (Senet), V.KLEBAN (Everynet), J.KNAPP (Semtech), T.KRAMP (Semtech), M.KUYPER (Semtech), P.KWOK (Objenious), M.LEGOURIEREC (Sagemcom), C.LEVASSEUR (Bouygues Telecom), M.LUIS (Semtech), M.PAULIAC (Gemalto), P.PIETRI (Orbiwise), O.SELLER (Semtech), D.SMITH (MultiTech), N.SORNIIN (Semtech), R.SOSS (Actility), J.STOKKING (The Things Network), T.TASHIRO (M2B Communications), D.THOLL (Tektelic), P.THOMSEN (Orbiwise), A.YEGIN (Actility)

Version: 1.0.4

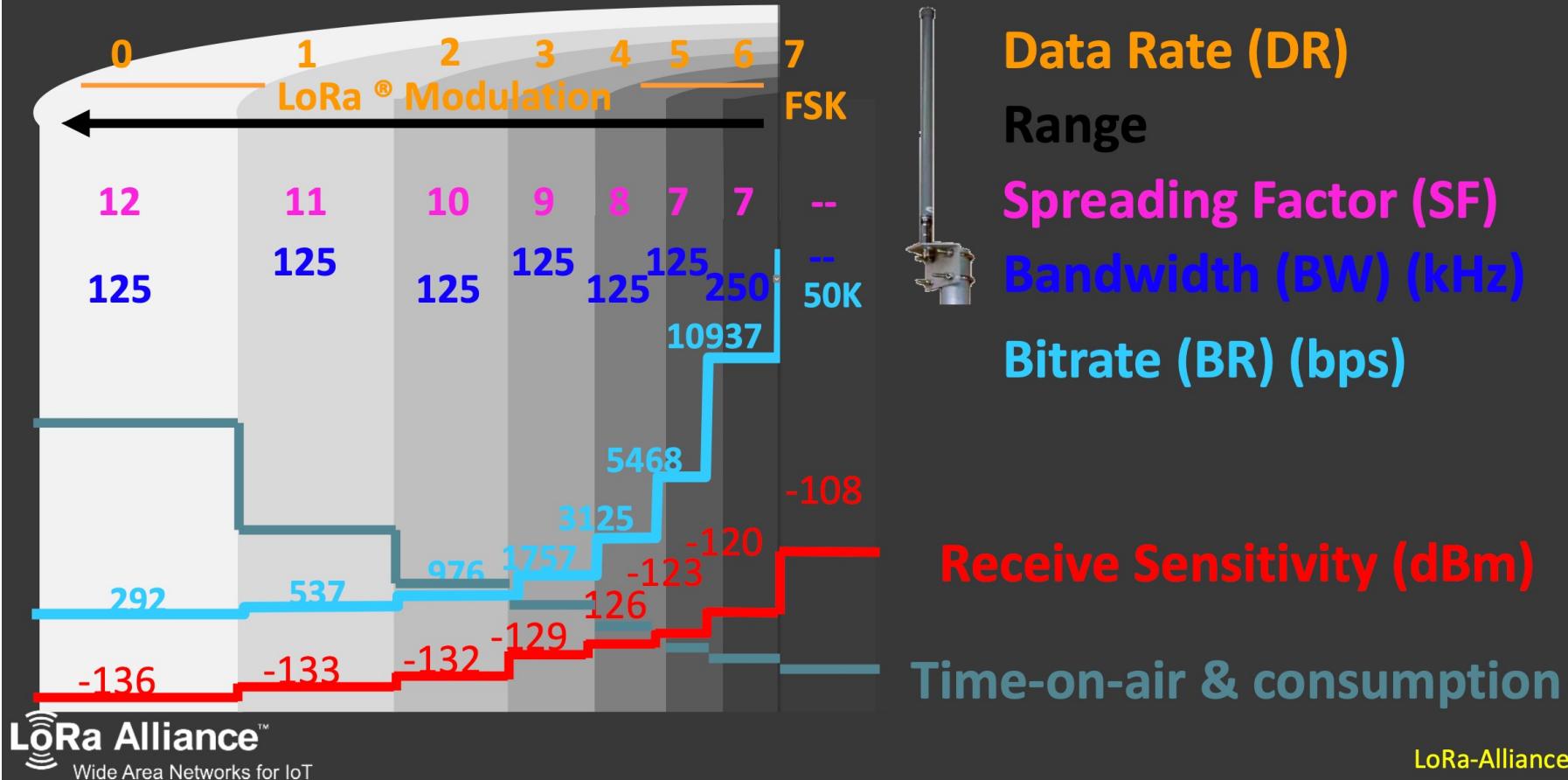
Date: October 2020

Status: Released

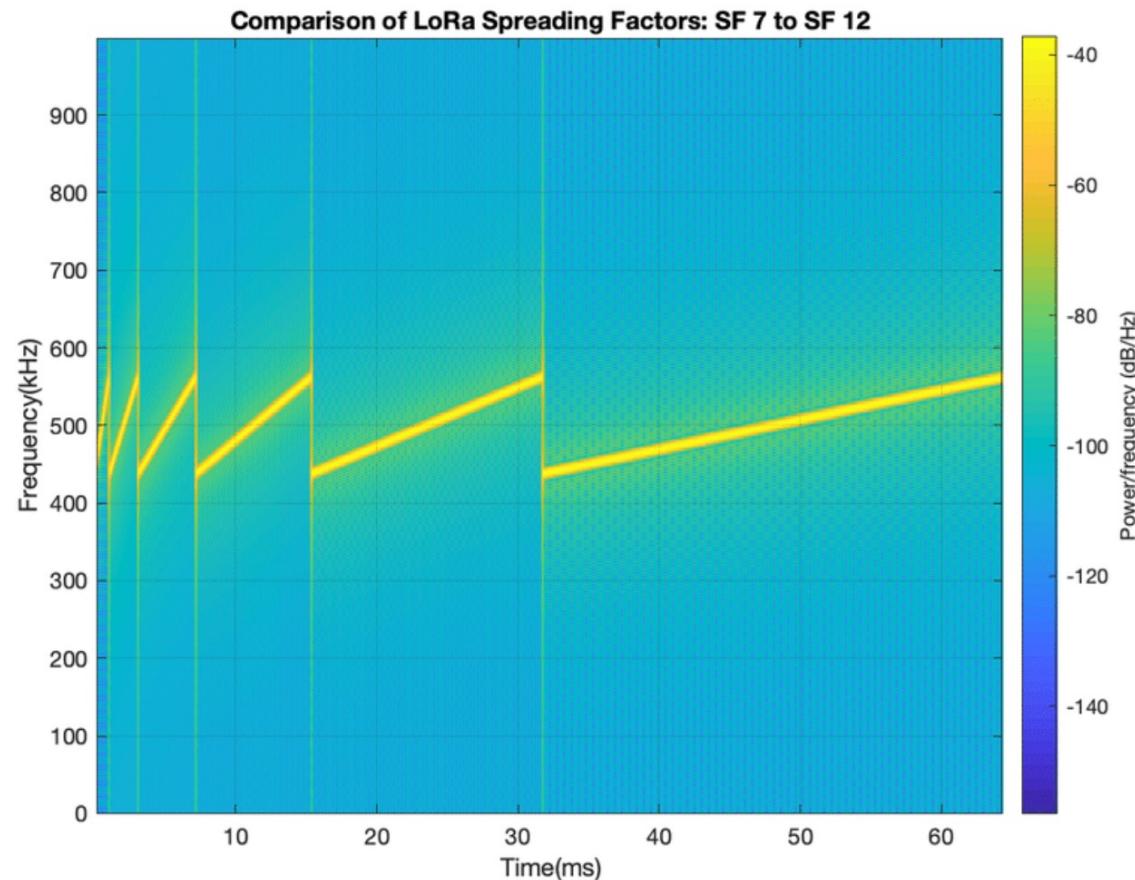


UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

LoRaWAN characterizing parameters



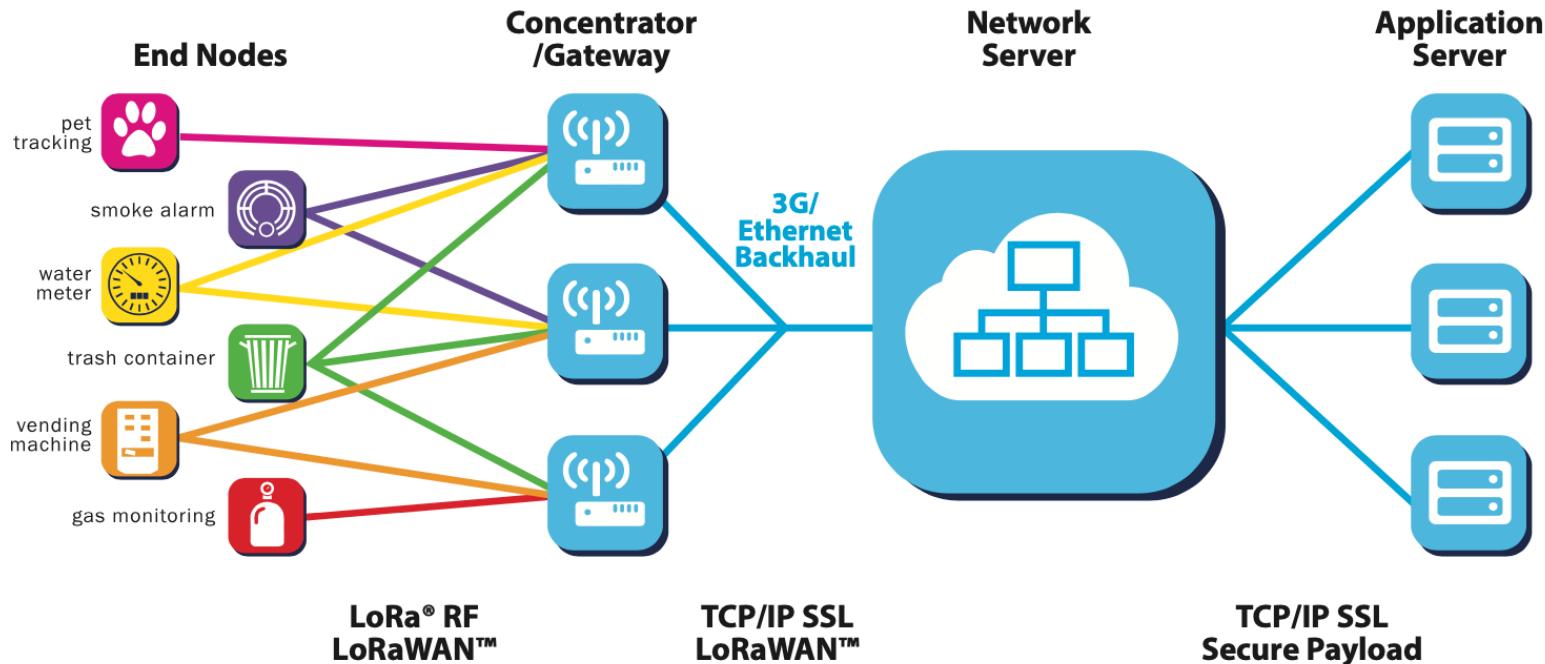
Chirp Modulation



<https://www.youtube.com/watch?v=dxYY097QNs0>

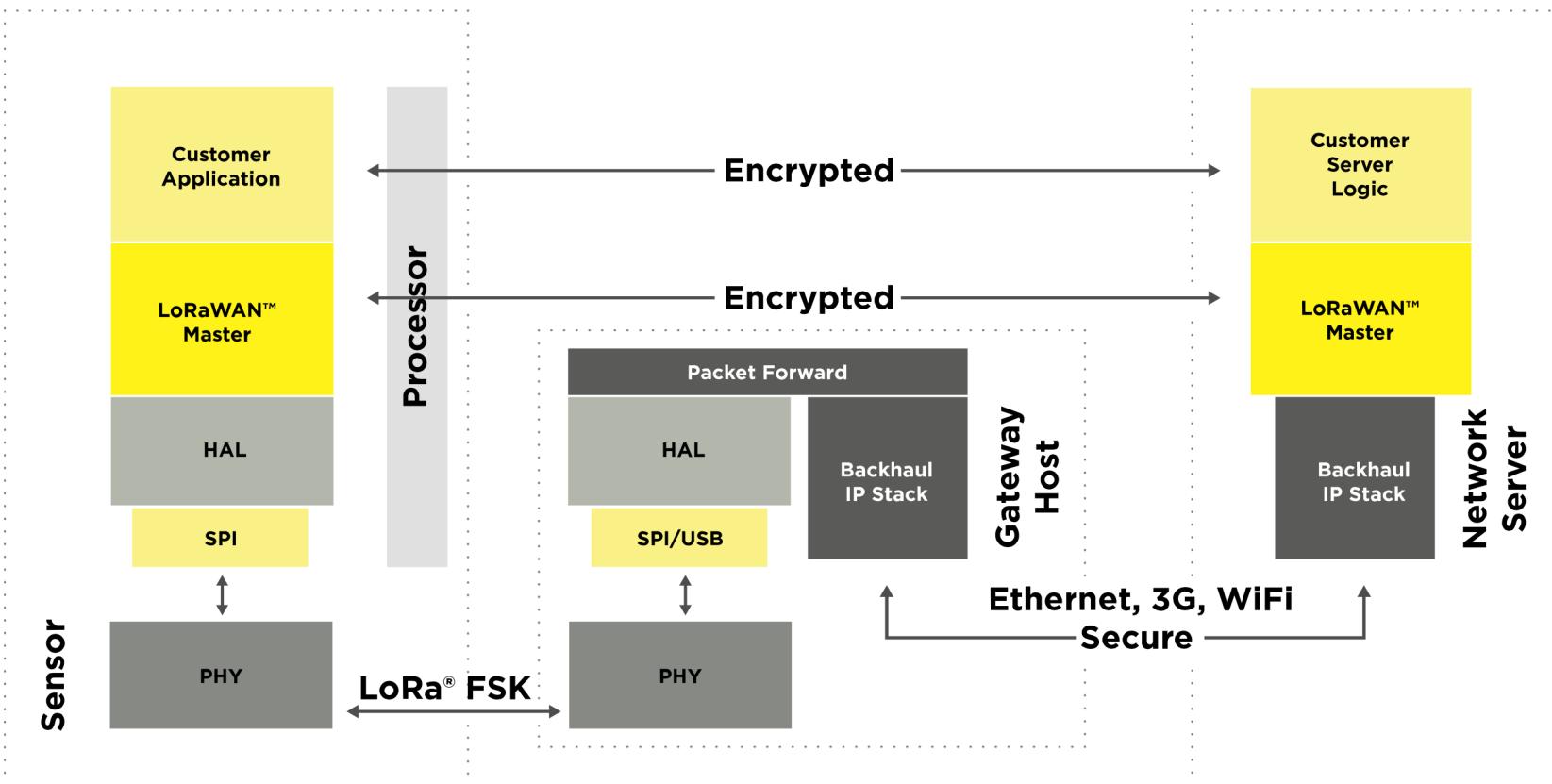
Kim, Dong-Hoon & Lee, Eun-Kyu & Kim, Jibum. (2019). Experiencing LoRa Network Establishment on a Smart Energy Campus Testbed. Sustainability. 11. 1917. 10.3390/su11071917.

LoRaWAN network architecture



LoRa Alliance ©

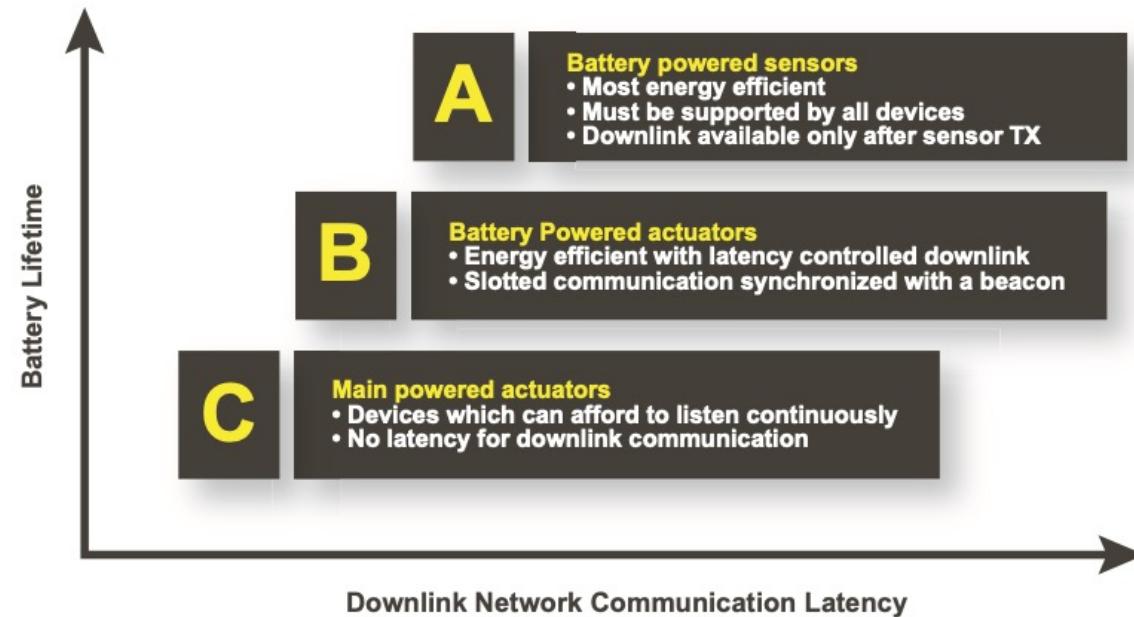
LoRaWAN data flow



HAL: Hardware Abstraction Layer

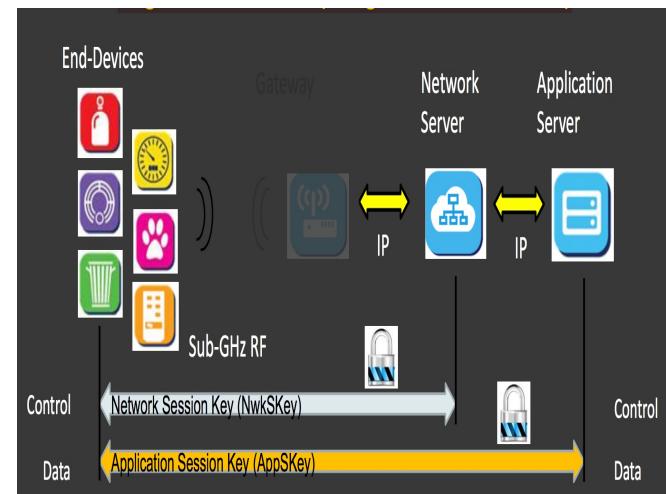
Three types of devices

- LoRaWAN has three different classes of end-point devices to address the different needs reflected in the wide range of applications:



LoRa® Alliance Technical Marketing Workgroup

- LoRaWAN devices have a 64-bits unique identifier (`DevEUI`) that is assigned to the device by the chip manufacturer.
- All communication is done with a dynamic 32 bit device address (`DevAddr`) of which 7 bits are fixed (Network Server), leaving 25 bits that can be assigned to individual devices with a procedure called **Activation**.
 - Over-the-Air Activation (**OTAA**)
 - Devices perform a join-procedure with the network, during which a dynamic `DevAddr` is assigned and security keys are negotiated with the device
 - Activation By Personalization (**ABP**)
 - Hardcode the `DevAddr` as well as the security keys in the device.



- The **duty cycle of radio devices is often regulated by government**. In Europe, duty cycles are regulated by section 7.2.3 of the ETSI EN300.220 standard.

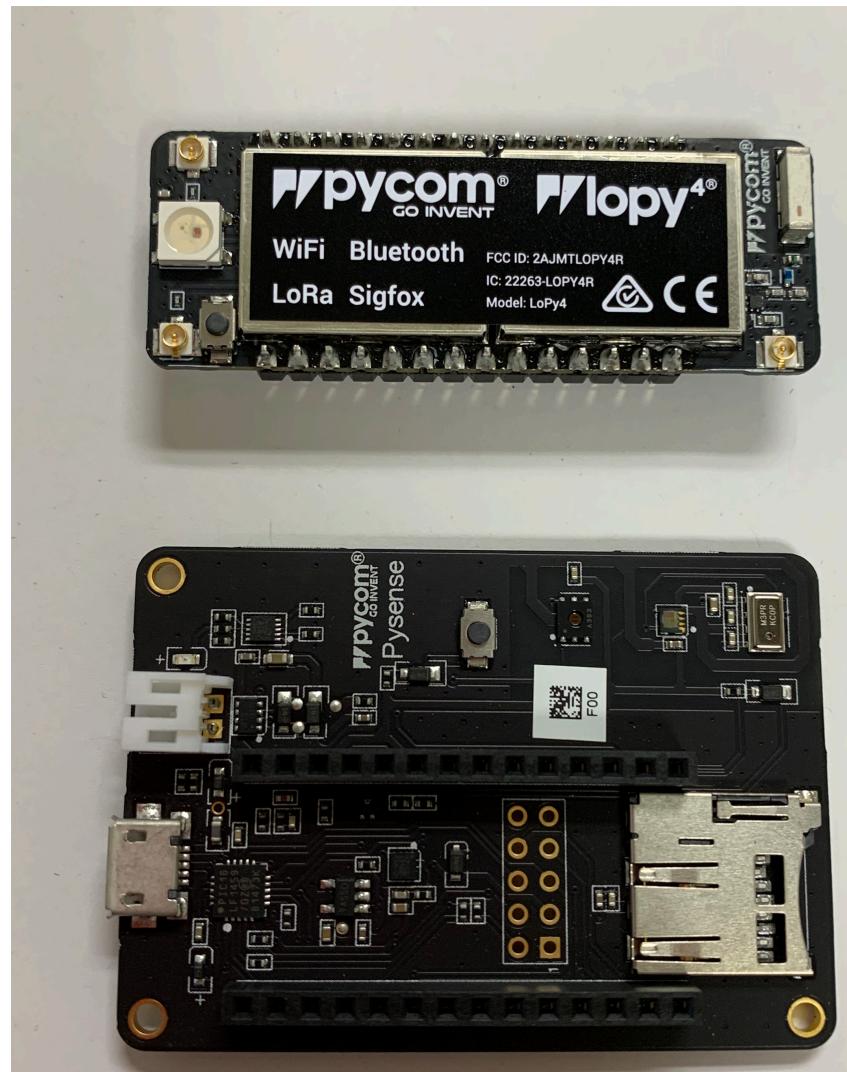
Duty Cycle indicates the fraction of time a resource is busy.

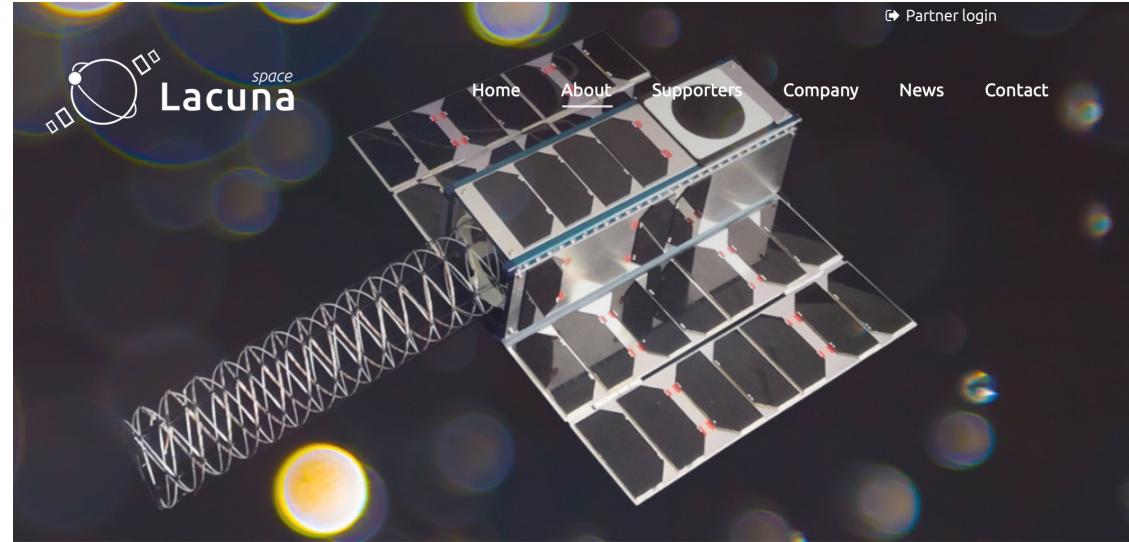
When a single device transmits on a channel for 2 *time units* every 10 *time units*, this device has a duty cycle of 20%.



- On “community network” like TTN there typically is a **Fair Access Policy** that limits the uplink airtime to 30 seconds per day (24 hours) per node and the downlink messages to 10 messages per day (24 hours) per node.

Some devices



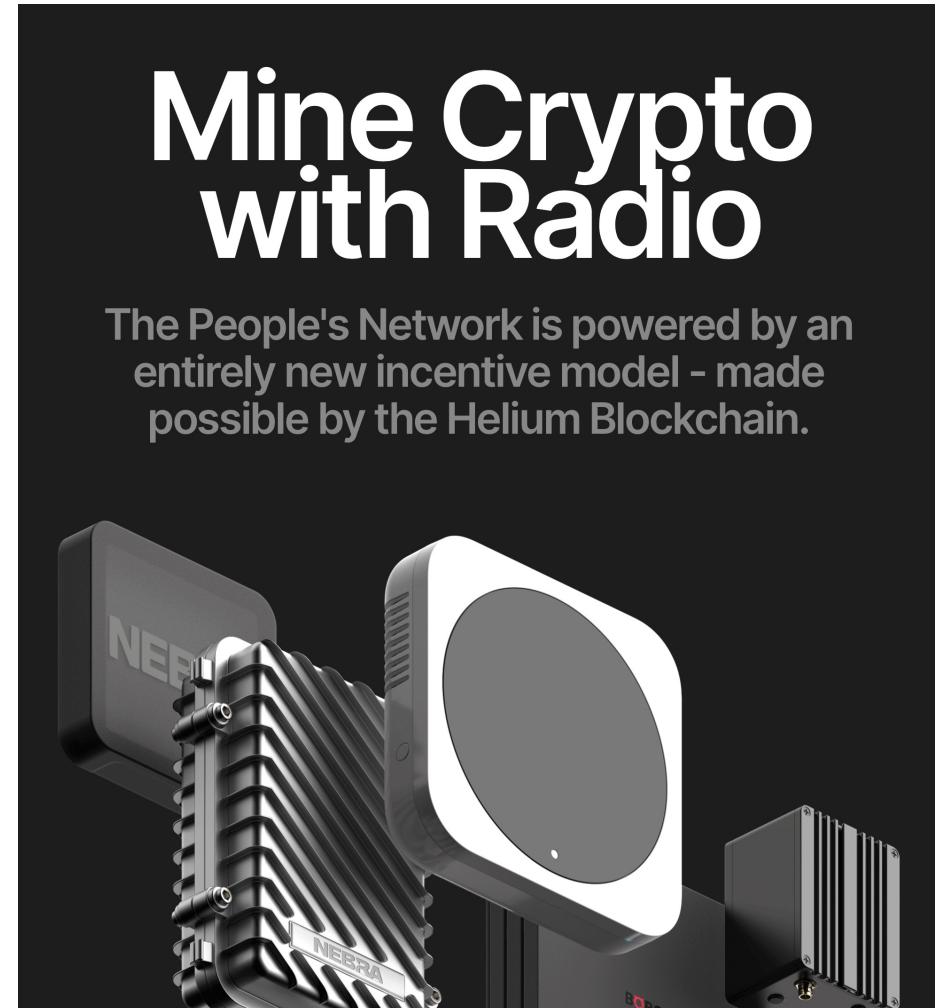


An ultra-low cost tracking and sensor detection service for small amounts of data

– think of it as ‘things’ rather than people tweeting short messages.



Helium's network is referred to as The People's Network. It is powered by an entirely new incentive model – made possible by the Helium Blockchain. Installing a LoRa Hotspot means you are rewarded in HNT crypto coins as soon as you have "Proof-of-Coverage".



LoRaWAN Network Servers



LORIOT AG is a global IoT company, founded in Switzerland in 2015. Our core product today is software for scalable, distributed, resilient operation of LoRaWAN® networks and end-to-end applications, which we offer under a variety of business models.

<https://www.loriot.io/>

<https://www.thethingsnetwork.org>

The Things Network (TTN)

The Things Network (TTN) is a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.

Start building Learn more

27.2M
Messages today

151
Countries

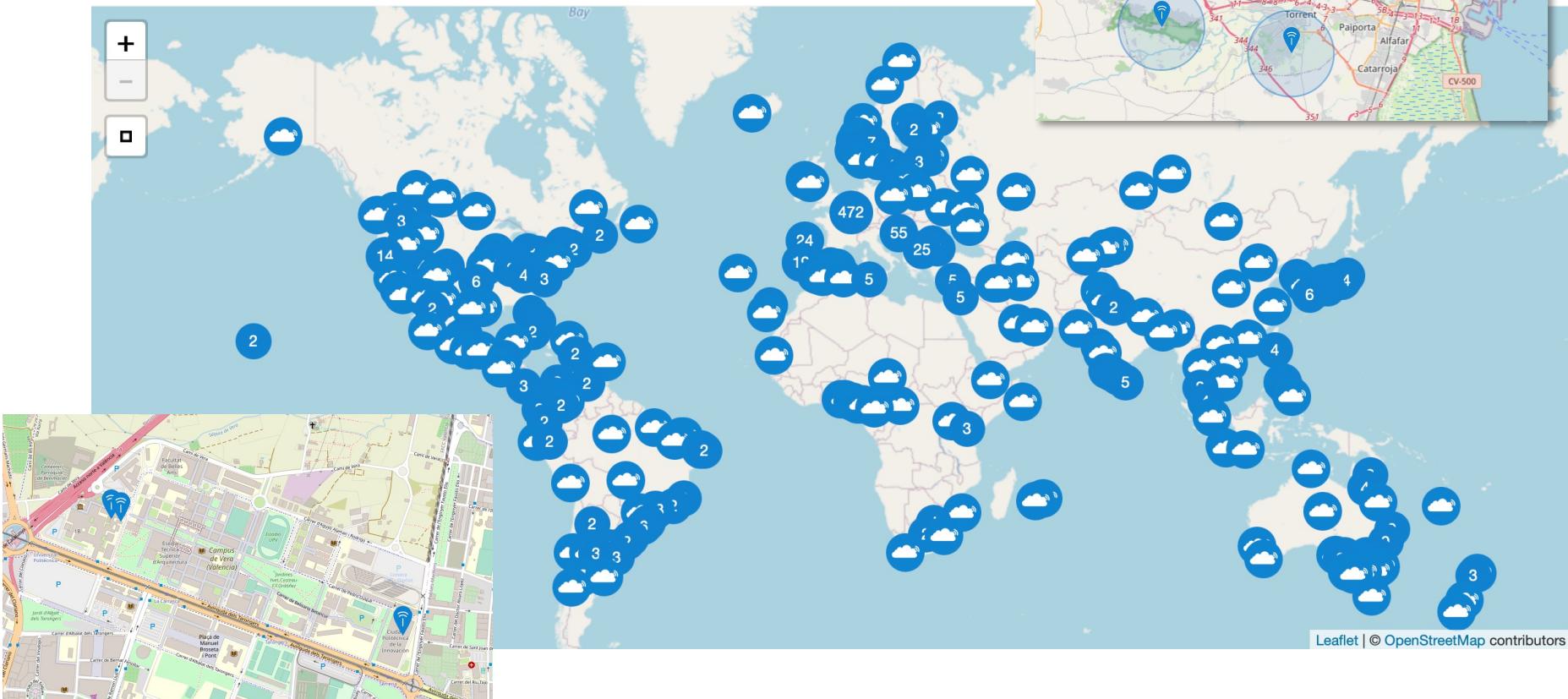
970
Certified developers

154.6K
Members

21.3K
Gateways

LoRaWAN Network ServersThe Things Network (TTN)

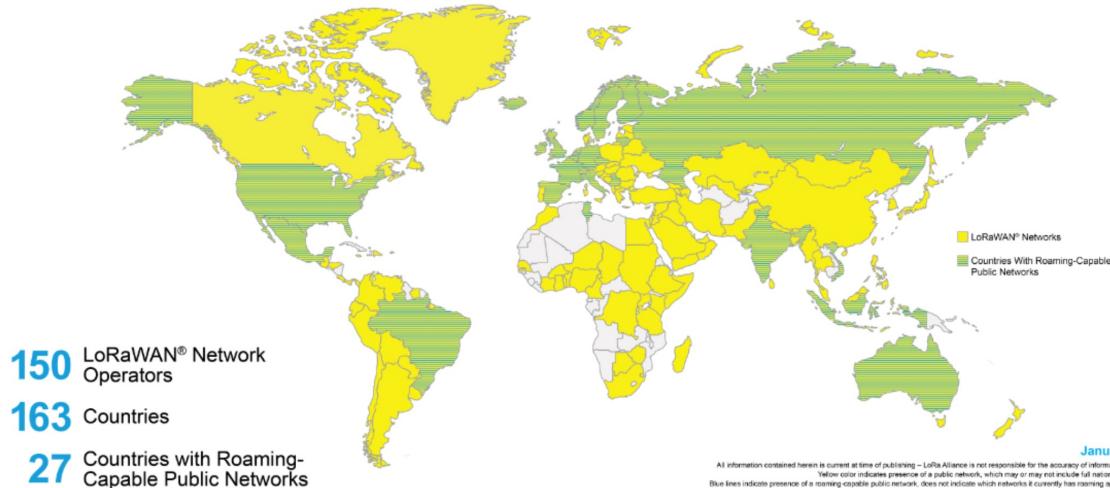
Currently (30mar2022) 19900 gateways active worldwide



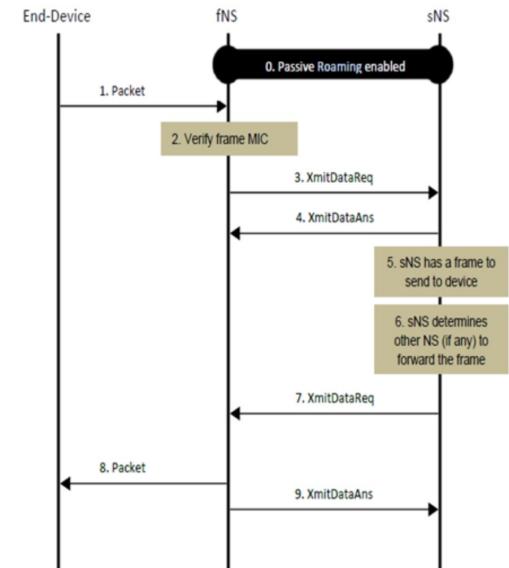
<https://eu1.cloud.thethings.network/console/>

LoRaWAN® Roaming

Availability of LoRaWAN® Networks and Roaming Capability



Passive Roaming



or..



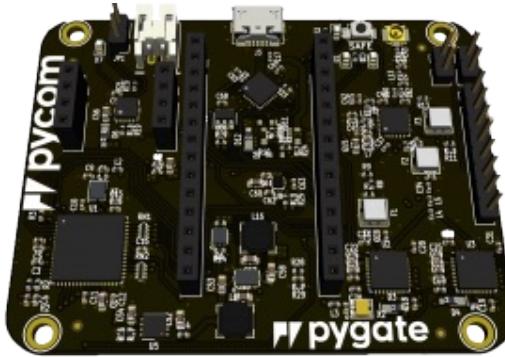
<https://packetbroker.net>

A **neutral** and **open** Internet of Things packet broker
allowing IoT operators to interoperate according to the open
principles of the internet.

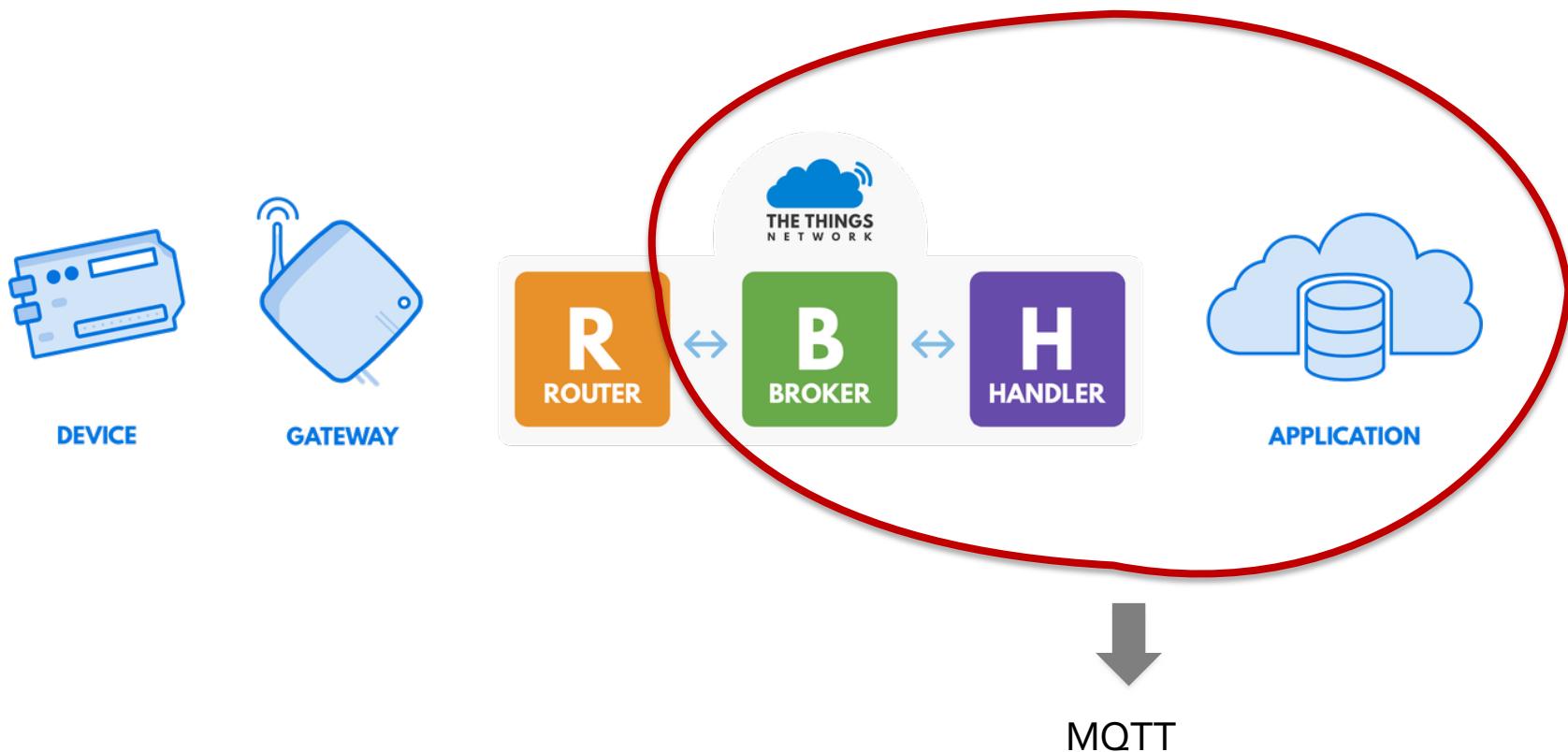


UNIVERSITAT
POLIÈCNICA
DE
VALÈNCIA

GRC Gateways



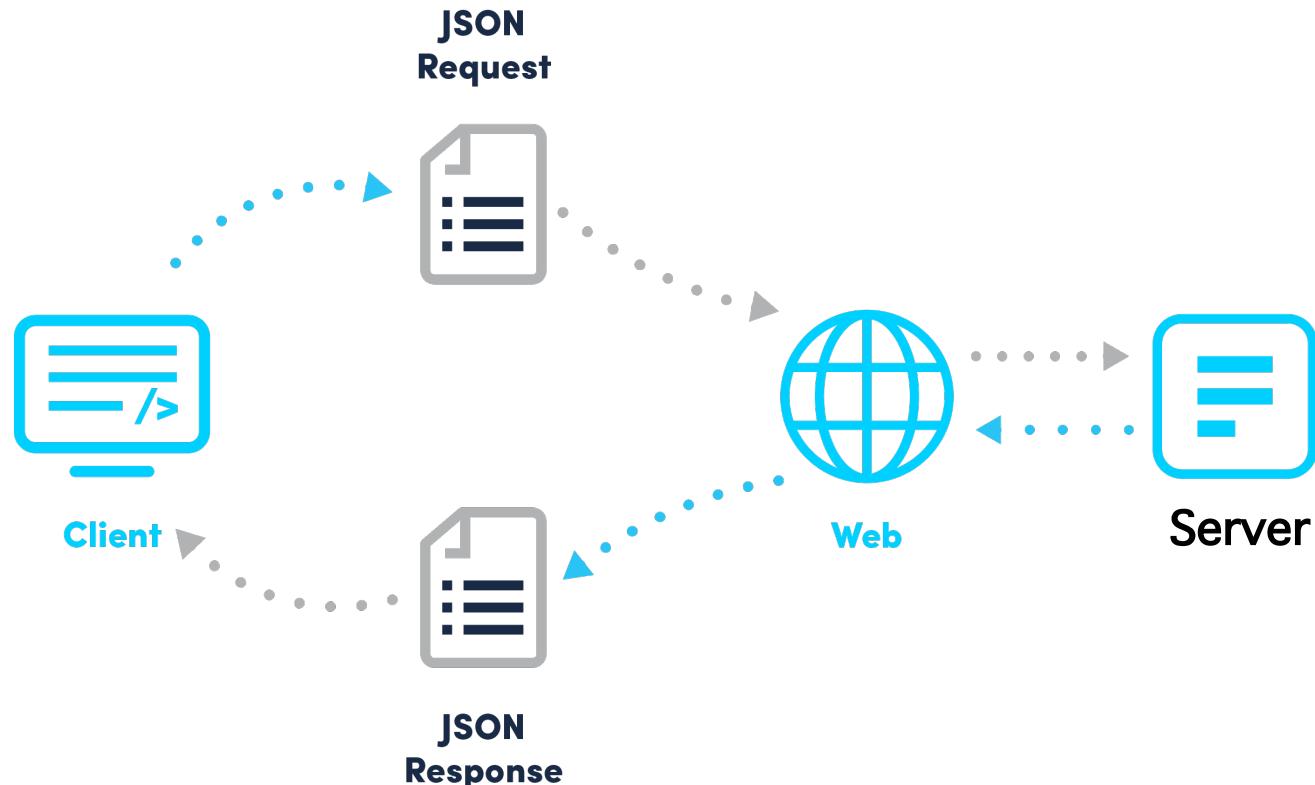
The Things Network (TTN)



A brief introduction to MQTT

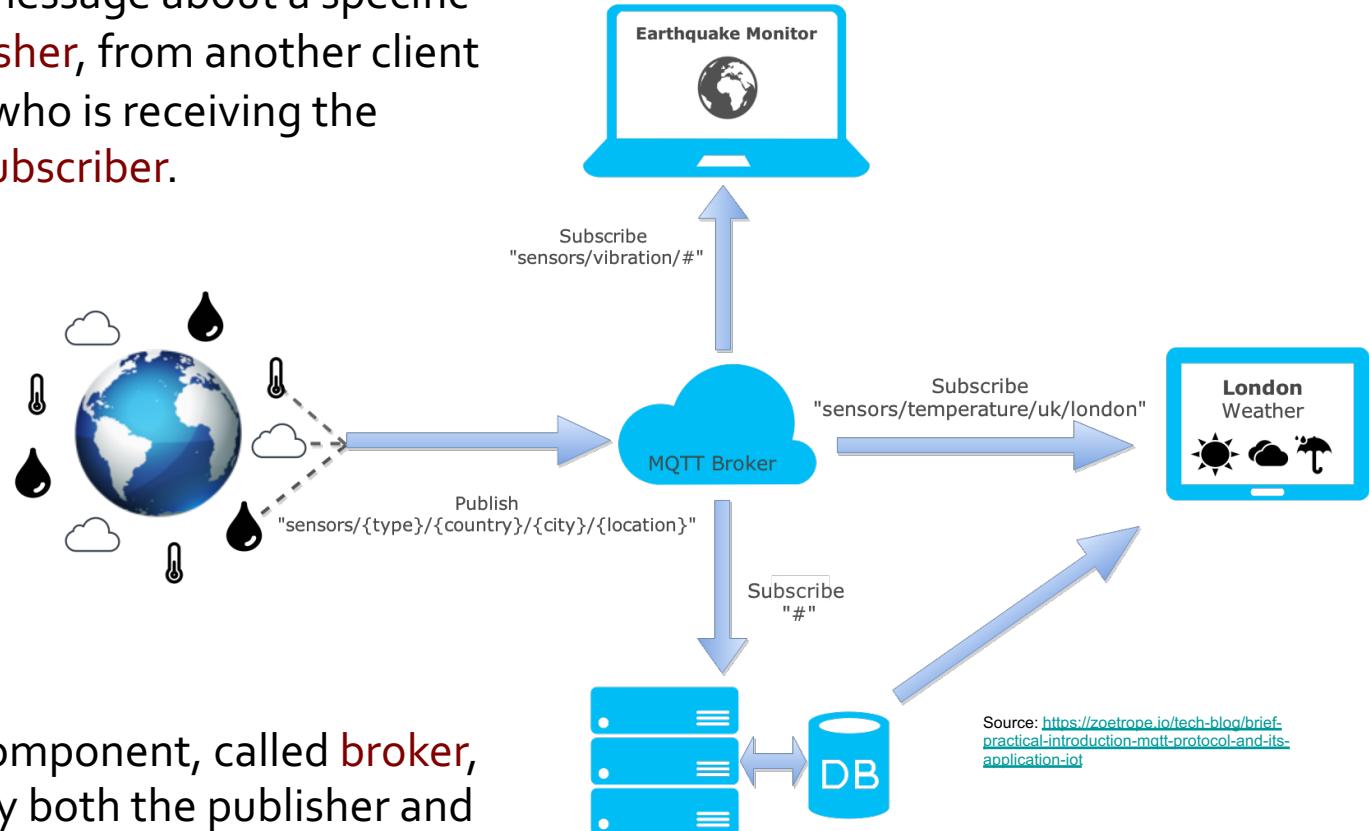
Request/response approach

- REST: Representational State Transfer
- Widely used; based on HTTP
- *Lighter version: CoAP (Constrained Application Protocol)*



Pub/sub approach: an example

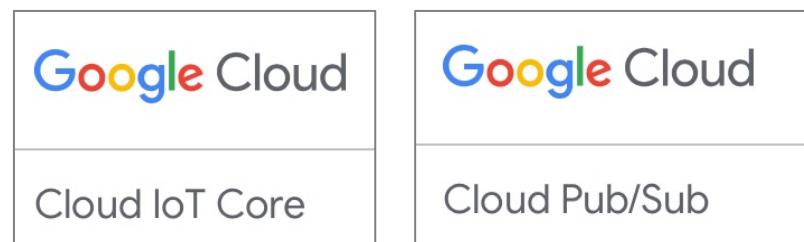
- Pub/Sub separate a client (or more clients), who is sending a message about a specific **topic**, called **publisher**, from another client (or more clients), who is receiving the message, called **subscriber**.



- There is a third component, called **broker**, which is known by both the publisher and subscriber, which filters all incoming messages and distributes them accordingly.

Pub/sub approach: a growing approach

- Various protocols:
 - AMQP, XMPP (was Jabber), ... **MQTT**



<https://cloud.google.com/iot/docs/how-tos/mqtt-bridge>

<https://cloud.google.com/pubsub/>

Redis

The open source, in-memory data store used by millions of developers as a database, cache, streaming engine, and message broker.

Get Started

Read the docs

<https://redis.io/docs/manual/pubsub/>

<https://kafka.apache.org>



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

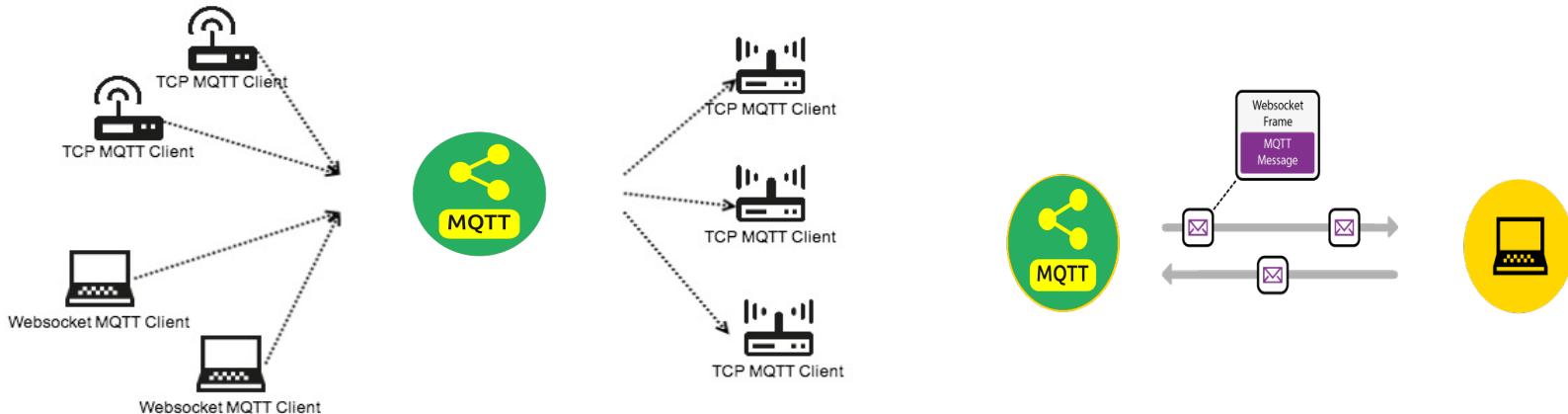
- A **lightweight publish-subscribe protocol** that can run on embedded devices and mobile platforms → <http://mqtt.org/>
 - Low power usage.
 - Binary compressed headers
 - Maximum message size of 256MB
 - not really designed for sending large amounts of data
 - better at a high volume of low size messages.
- Documentation sources:
 - The MQTT community wiki:
 - <https://github.com/mqtt/mqtt.github.io/wiki>
 - A very good tutorial:
 - <http://www.hivemq.com/mqtt-essentials/>

Some details about versions

- **MQTT 3.1.1 is the current version of the protocol.**
 - Standard document here:
 - <http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html>
 - October 29th 2014: MQTT was officially approved as OASIS Standard.
 - https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=mqtt
- MQTT v5.0 is the successor of MQTT 3.1.1
 - Current status: Committee Specification 02 (7 March 2019)
 - <http://docs.oasis-open.org/mqtt/mqtt/v5.0/cs02/mqtt-v5.0-cs02.html>
 - **Not backward compatible**; too many new things are introduced so existing implementations have to be revisited, for example:
 1. More extensibility → user properties
 2. Improved error reporting (Reason Code & Reason String)
 3. Performance improvements and improved support for small clients
 - shared subscriptions
 - topic alias
 4. Formalized common patterns → payload format description
 5. Improved authentication

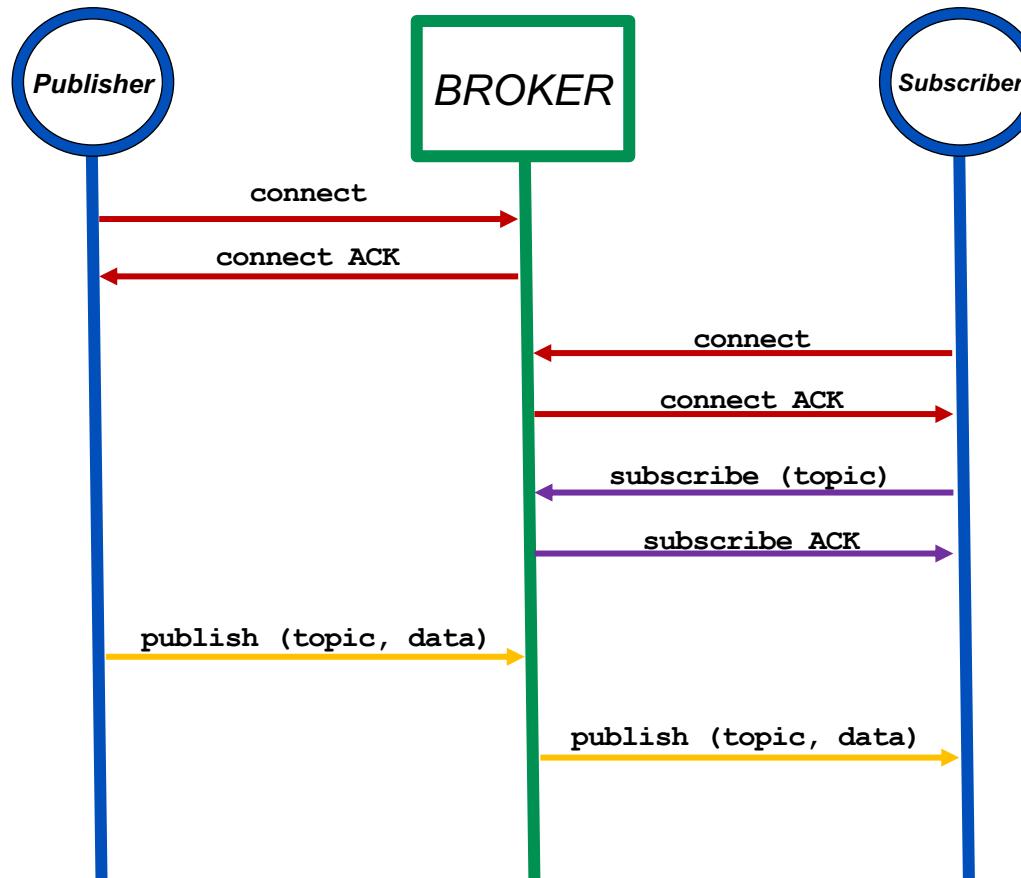
MQTT works on top of...

- mainly of TCP
 - There is also the closely related **MQTT for Sensor Networks (MQTT-SN)** where TCP is replaced by UDP → TCP stack is too complex for WSN
- websockets can be used, too!
 - Websockets allows you to receive MQTT data directly into a web browser.



- Both, TCP & websockets can work on top of “Transport Layer Security (TLS)” (and its predecessor, Secure Sockets Layer (SSL))

Publish/subscribe interactions sequence



- MQTT Topics are structured in a hierarchy similar to folders and files in a file system using the forward slash (/) as a delimiter.
- Allow to create a user friendly and self descriptive **naming structures**

- Topic names are:
 - Case sensitive
 - use UTF-8 strings.
 - Must consist of at least one character to be valid.
- Except for the \$SYS topic **there is no default or standard topic structure.**



Special \$SYS/ topics

- \$SYS/broker/clients/connected
- \$SYS/broker/clients/disconnected
- \$SYS/broker/clients/total
- \$SYS/broker/messages/sent
- \$SYS/broker/uptime

- Topic subscriptions can have wildcards. These enable nodes to subscribe to groups of topics that don't exist yet, allowing greater flexibility in the network's messaging structure.
 - '+' matches anything at a given tree level
 - '#' matches a whole sub-tree
- Examples:
 - Subscribing to topic `house/#` covers:
 - `house/room1/main-light/left/red`
 - `house/room1/alarm`
 - `house/garage/main-light`
 - `house/main-door/lock/upper`
 - Subscribing to topic `house/+/main-light` covers:
 - `house/room1/main-light`
 - `house/room2/main-light`
 - `house/garage/main-light`
 - but doesn't cover
 - `house/room1/side-light`
 - `house/room2/front-light`

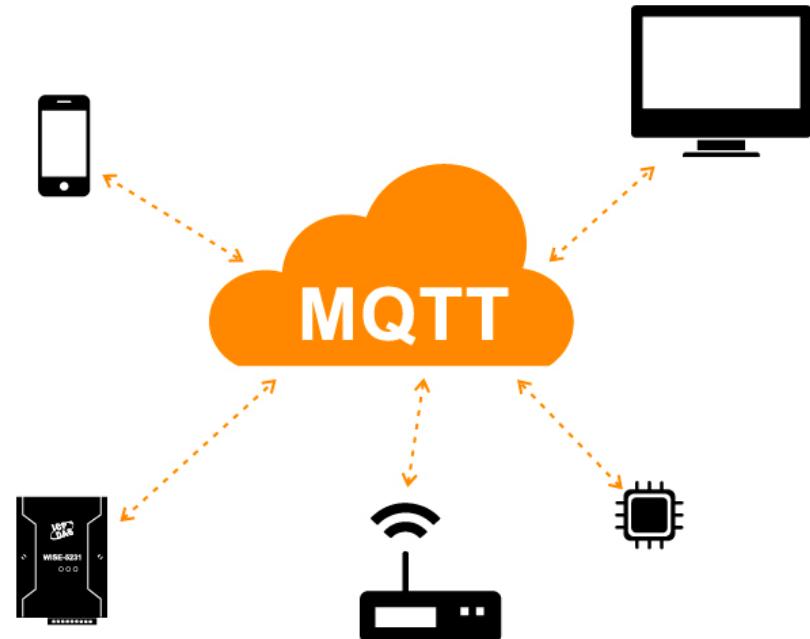
- MQTT has the option for Transport Layer Security (TLS) encryption.
- MQTT also provides username/password authentication with the broker.
 - Note that the password is transmitted in clear text. Thus, be sure to use TLS encryption if you are using authentication.



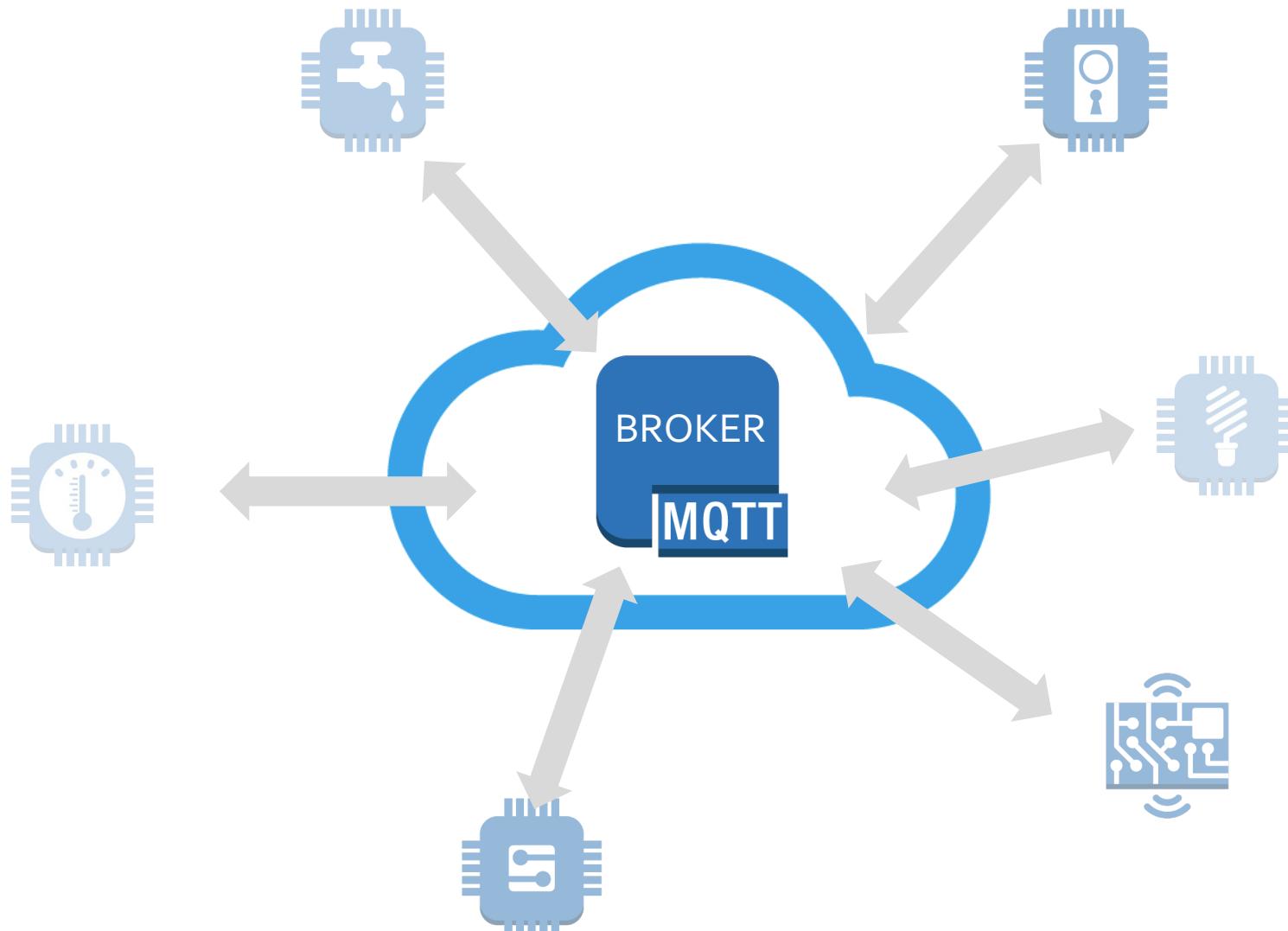
"It's not just you. We're all insecure in one way or another."

Intro to MQTT

- ✓ Brokers and clients



Creating a broker



Available MQTT brokers

- The most widely used are:
 - <http://mosquitto.org/>
 - man page: <https://mosquitto.org/man/mosquitto-8.html>
 - <http://www.hivemq.com/>
 - The standard trial version only supports 25 connections.
- And also:
 - <https://www.rabbitmq.com/mqtt.html>
 - <http://activemq.apache.org/mqtt.html>
- A quite complete list can be found here:
 - <https://github.com/mqtt/mqtt.github.io/wiki/servers>

Cloud based MQTT brokers: CloudMQTT

<https://www.cloudmqtt.com/>

→ based on Mosquitto

CloudMQTT

Pricing Documentation Support Blog

Hosted message broker for the Internet of Things



Power Pug

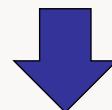
- Up to 10 000 connections
- No artificial limitations
- Support by e-mail
- Support by phone

\$ 299

PER MONTH

Get Now

mized message queues for IoT, ready in seconds.



Humble Hedgehog

- 25 users/acl rules/connections
- 20 Kbit/s
- 3 bridges
- Support by e-mail

\$ 5

PER MONTH

Get Now



Cloud based brokers: flespi

<https://flespi.com/mqtt-broker>

The screenshot shows the flespi MQTT broker landing page. At the top, there is a navigation bar with links for Platform, Resources, Terms of use, About us, Blog, a search icon, and a 'GET STARTED' button. The main title 'MQTT broker' is displayed prominently. Below the title, a brief description states: 'Fast, secure, and free public MQTT broker with MQTT 5.0 support, private namespace, WSS, ACLs, and rich API.' To the right of the text, there is a graphic of a central grey cloud icon connected by arrows to four colored circles (blue, yellow, red, green) arranged in a square pattern.

MQTT broker

Fast, secure, and free public MQTT broker with MQTT 5.0 support, private namespace, WSS, ACLs, and rich API.

- flespi MQTT broker architecure
- MQTT as a remote distributed storage system
- MQTT as the foundation for event-driven web-application design

Also check out [MQTT Board](#) - our MQTT 5.0 client tool for debugging and testing.

Cloud based brokers: flespi

Terms of use

Free \$0/mo

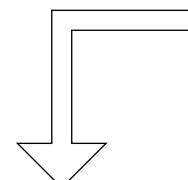
MQTT

100 active MQTT sessions

<https://flespi.io/#/panel/mqttboard>

The screenshot shows the flespi v.3.7.0 interface. On the left, a sidebar lists 'Tokens', 'MQTT' (selected), 'MQTT Board' (MQTT Client), 'Toolbox' (MQTT logs), 'MQTT Broker API' (Documentation), and 'YouTube Videos' (Manuals). The main area is titled 'mqtt-board-panel-3de8eb91'. It contains two panels: 'Subscriber' (orange) and 'Publisher' (blue). The Subscriber panel has a 'Topic' field set to '#', 'QoS' options (0, 1, 2), and checkboxes for 'No local' and 'Retain as Published'. The Publisher panel has a 'Topic' field set to 'my/topic', a 'Message' field containing '{"hello": "world"}', and 'Options' for QoS (0, 1, 2), 'Retain', and 'Duplicate flag'.

<https://flespi.com/mqtt-api>



flespi MQTT broker connection details

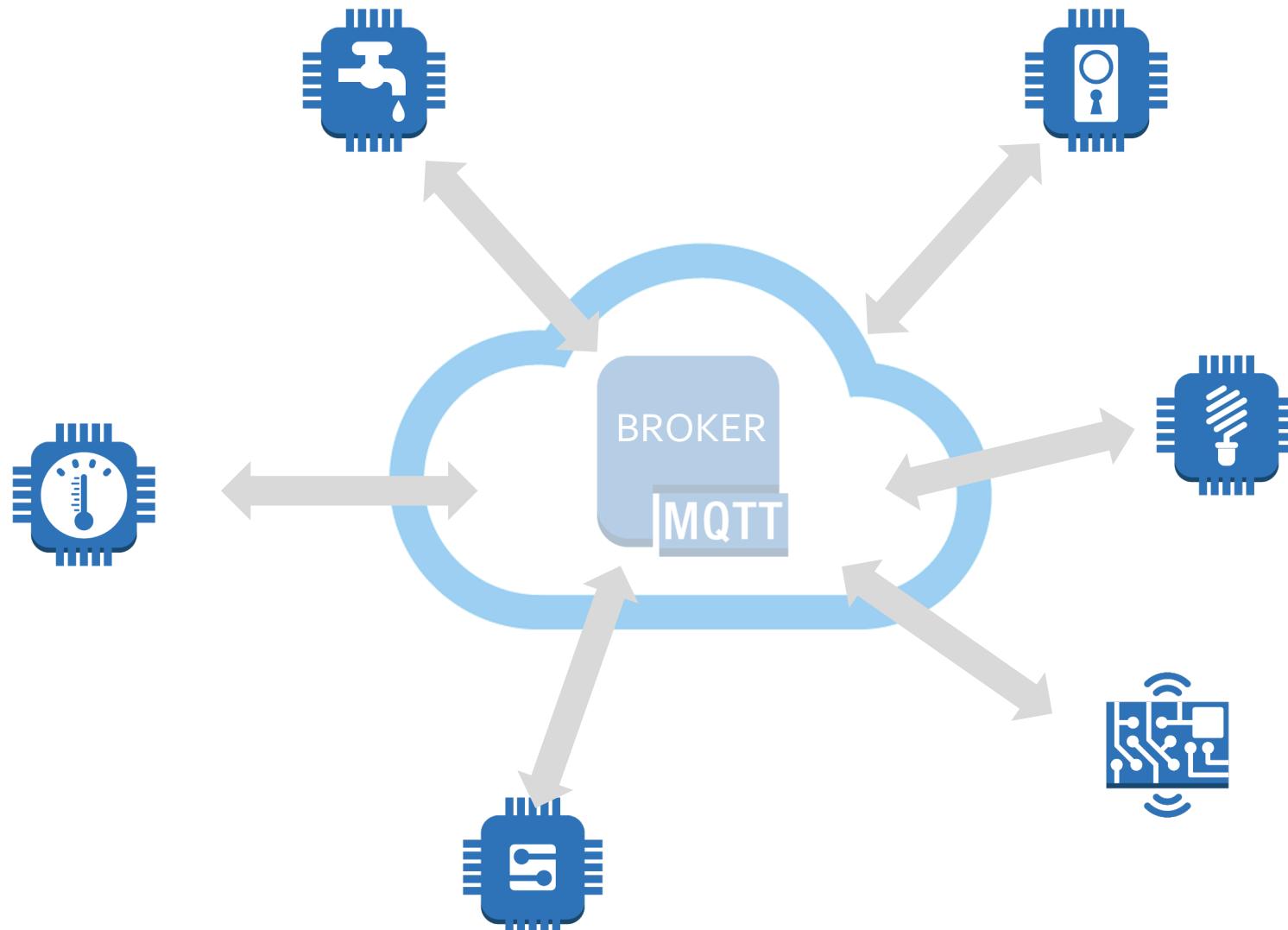
- **Host** — mqtt.flespi.io.
- **Port** — [8883 \[SSL\]](#) or [1883 \[non-SSL\]](#); for MQTT over WebSockets: [443 \[SSL\]](#) or [80 \[non-SSL\]](#).
- **Authorization** — use a [flespi platform token](#) as MQTT session username; no password.
- **Client ID** — use any unique identifier within your flespi user session.
- **Topic** — you can publish messages to any topic except [flespi/](#).
- **ACL** — both [flespi/](#) and [MQTT pub/sub](#) restrictions determined by the token.

I1RKMMIUJpp1QoSgAQ8MvDUJWNNJ9R2HIJgiijo1S1gt5rajaeIOaiaKWwlHt2z1z



- TCP based:
 - <https://iot.eclipse.org/getting-started/#sandboxes>
 - Hostname: **iot.eclipse.org**
 - <http://test.mosquitto.org/>
 - Hostname: **test.mosquitto.org**
 - <https://www.hivemq.com/mqtt-demo/>
 - Hostname: **broker.hivemq.com**
 - <http://www.mqtt-dashboard.com/>
 - Ports:
 - standard: 1883
 - encrypted: 8883 (*TLS v1.2, v1.1 or v1.0 with x509 certificates*)
- Websockets based:
 - broker.mqttdashboard.com port: 8000
 - test.mosquitto.org port: 8080
 - broker.hivemq.com port: 8000
- https://github.com/mqtt/mqtt.github.io/wiki/public_brokers

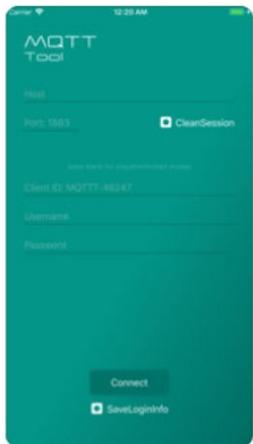
Creating clients



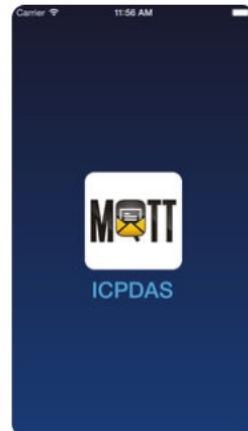
MQTT clients: iOS



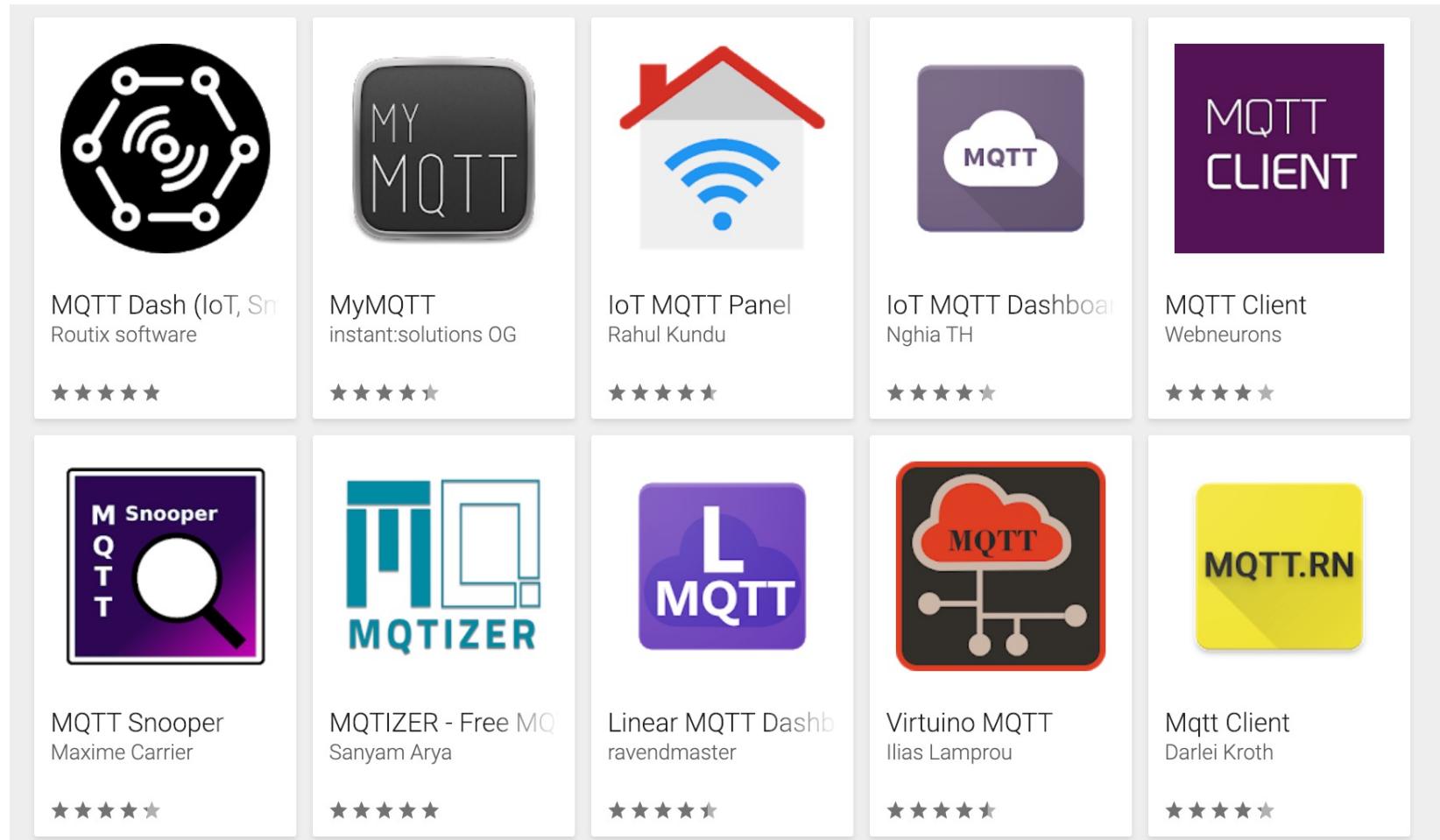
Mqttt
Utilidades



ICPDAS MQ...
Utilidades



MQTT clients: Android



MQTT websocket clients

<http://test.mosquitto.org/ws.html>

MQTT over WebSockets

This is a very early/incomplete/broken example of MQTT over Websockets for test.mosquitto.org. Play around with the buttons below, but don't be surprised if it breaks or isn't very pretty. If you want to develop your own websockets/mqtt app, use the url ws://test.mosquitto.org/mqtt , use subprotocol "mqtt" (preferred) or "mqqtv3.1" (legacy) and binary data. Then just treat the websocket as a normal socket connection and read/write MQTT packets.

Usage

Click Connect, then use the Publish and/or Subscribe buttons. You should see text appear below. If you've got another mqtt client available, try subscribe to a topic here then use your other client to send a message to that topic.

Broker

[Connect](#) [Disconnect](#)

Publish

Topic:

Payload:

[Publish](#)

Subscrib



Connection

Host

broker.mqttdashboard.com

Port

8000

ClientID

clientId-EVU0qAkr8g

[Connect](#)

Username

Password

Keep Alive

60

Clean Session

Last-Will Topic

Last-Will QoS

0

Last-Will Retain

Last-Will Message

Publish



Subscriptions



Messages



<http://www.hivemq.com/demos/websocket-client/>

<http://mitsuruog.github.io/what-mqtt/>

The screenshot shows a dark-themed web application for testing MQTT over WebSockets. At the top, there's a 'MQTT on Websocket sample' header. On the left, a 'Broker' section includes 'Connect / Disconnect' buttons and fields for 'Topic:' and 'Payload:' with a 'Publish' button. In the center, a large area is labeled 'Websockets Client Showcase' with a 'Connection' configuration panel containing fields for Host, Port, ClientID, Username, Password, Keep Alive, Clean Session, Last-Will Topic, Last-Will QoS, and Last-Will Retain. Below this are sections for 'Publish' and 'Subscriptions'. On the right, there are 'MQTT broker on websocket' settings for 'Address:' (ws://broker.hivemq.com:8000/mqtt), a 'Subscribe / Unsubscribe' section with 'Topic:' (mitsuruog) and 'subscribe'/'unsubscribe' buttons, and a 'Publish' section with 'Topic:' (mitsuruog).



MQTT Explorer

An all-round MQTT client that provides a
structured topic overview