IoT y sus aplicaciones
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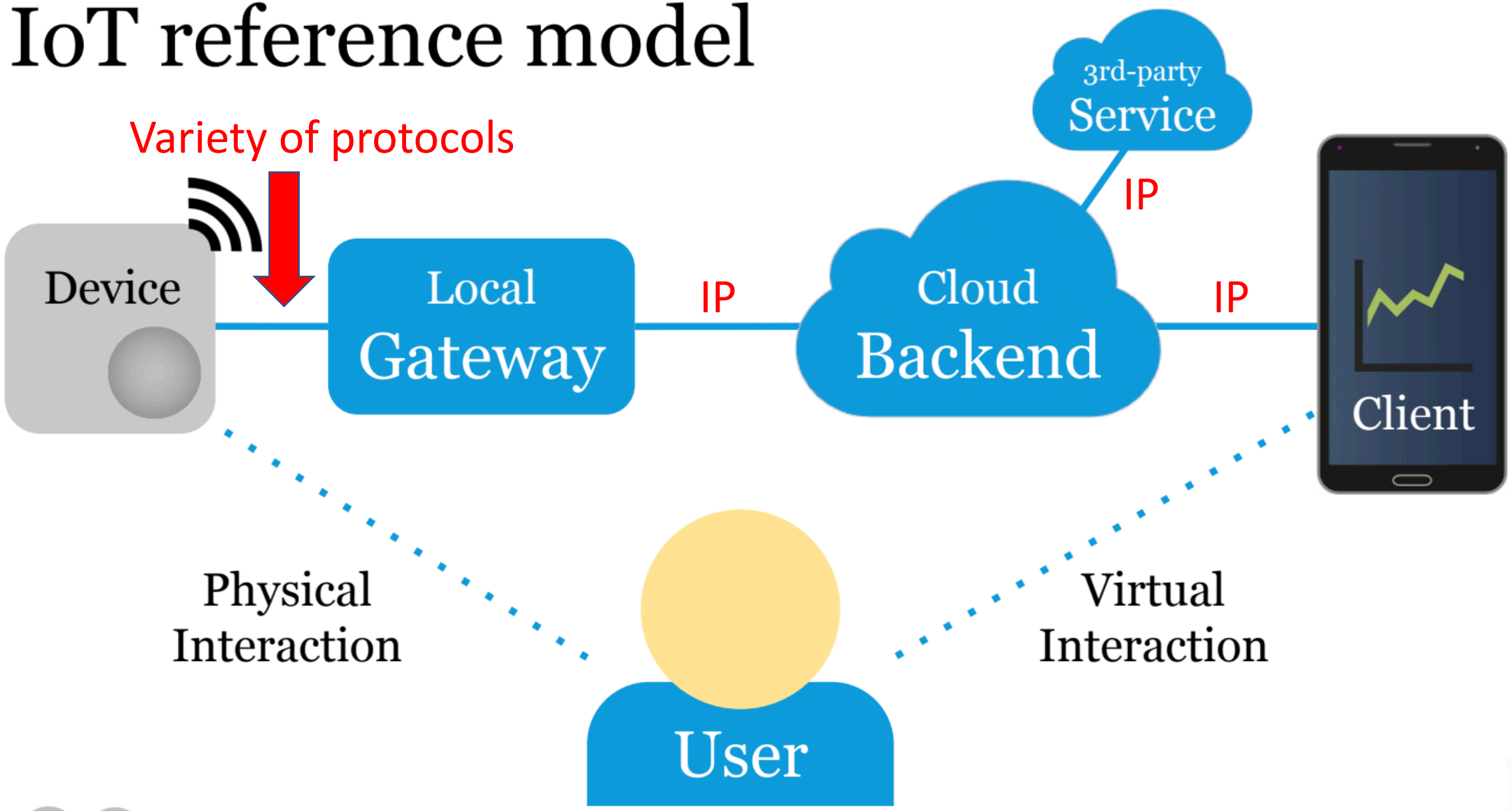
Goals

- Provide a glimpse of few of the countless applications of Internet of Things
- Realize that a single technology cannot effectively address the requirements of disparate use cases
- Issues to consider:
  - Licensed or unlicensed spectrum?
  - Proprietary or standard based?
  - Massive or Critical applications?

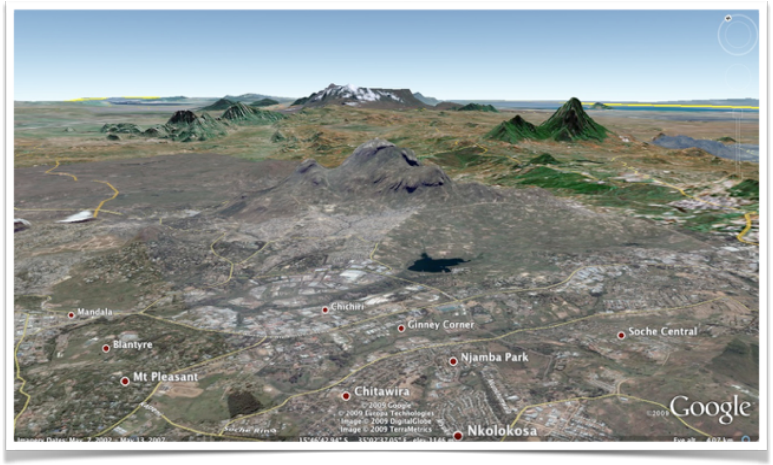
IoT reference model



ICTP

IoT networks potential requirements

- Low cost
- Energy efficiency
- Ubiquitous coverage
- Scalability to support massive deployments
- Extended coverage
- Security
- Confidentiality
- Geolocation capability



Some specific IoT issues

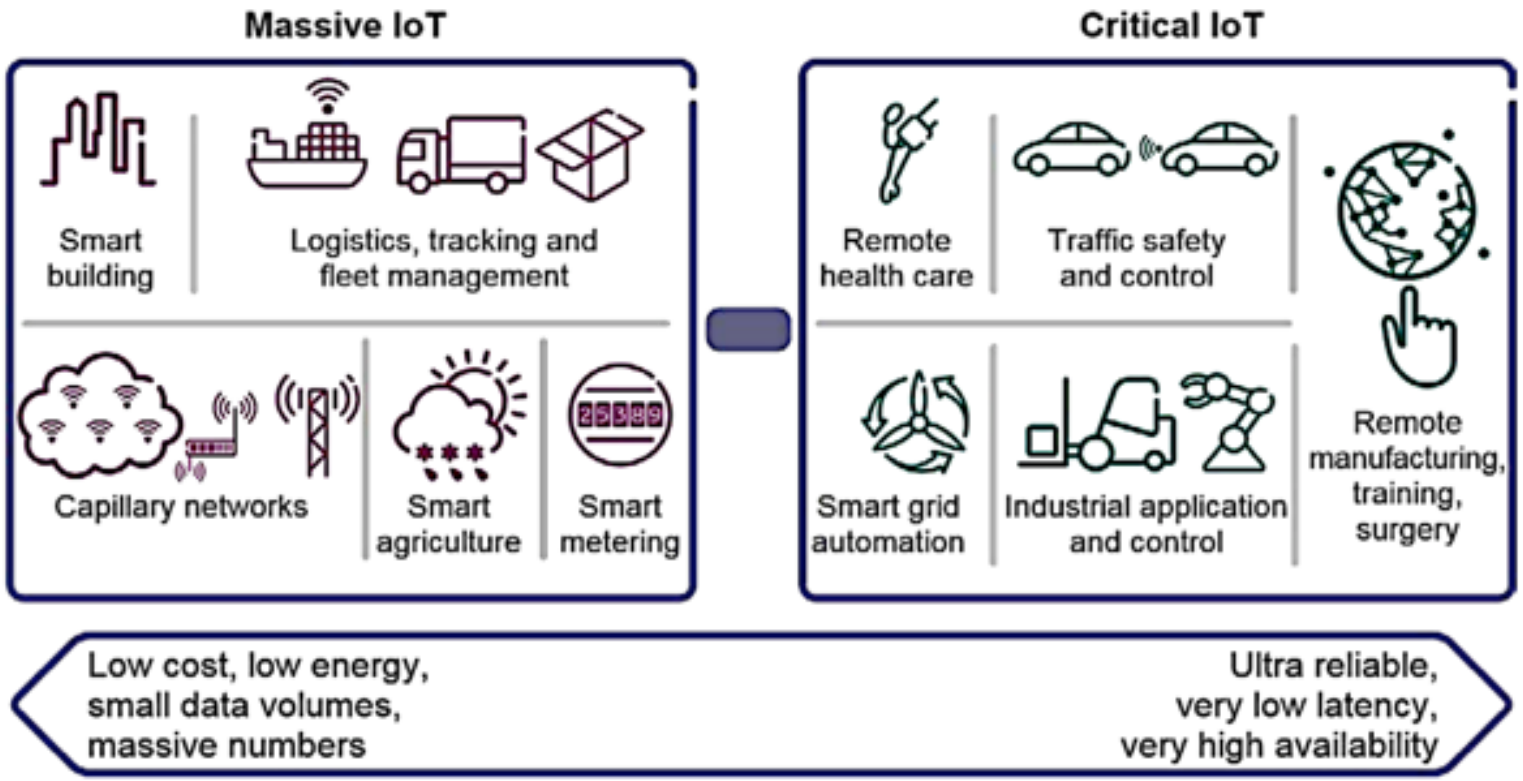
- Traffic pattern, payload size, periodicity, latency
- Identity and level of security required
- Reliability
- Sector specific regulations (for instance, health care)
- Analytics
- Billing and charging
- Service level agreements (SLA)
- QoS for specific equipment
- Mobility, positioning
- Capability to address group of devices with a single action

Basis for sustainability of a smart city

- Economic: The ability to generate income and employment for the livelihood of the inhabitants.
- Social: The ability to ensure that the welfare (safety, health, education, etc.) of the citizens can be equally delivered despite differences in class, race or gender.
- Environmental: The ability to protect future quality and reproducibility of natural resources.
- Governance: The ability to maintain social conditions of stability, democracy, participation and justice.
- Cultural: The ability to promote cultural identity and adequacy, value and emotional well-being.

From ITU-T Y.4903/L.1603

IoT Network Planning: Critical or Massive



From: Cellular Networks for Massive IOT, Ericsson white paper. January 2016.

IoT Applications: Critical or Massive?

Massive IoT

- Very cost sensitive
- Low consumption
- Small payloads
- Latency and loss tolerant
- Unlicensed frequencies acceptable
- Cloud back end
- Can be served by proprietary or cellular based solutions

Critical IoT

- Very high availability
- Very low latency
- Very high availability
- Variable payloads
- Licensed frequencies required in many cases to guarantee reliability
- Best served by cellular based solutions

Massive applications examples

LPWAN Proprietary

Advantages:

- Unlicensed spectrum.
- Low infrastructure cost.
- Can be independently managed or relay on existing service providers.
- Low power consumption.
- Might not incur in per device recurring cost.
- Currently greater market share.

Disadvantages

- No interference protection.
- No guarantee against future users of the same spectrum.
- No standards, fragmented market.
- New cellular based solutions are eroding market share.

3GPP solutions

Advantages:

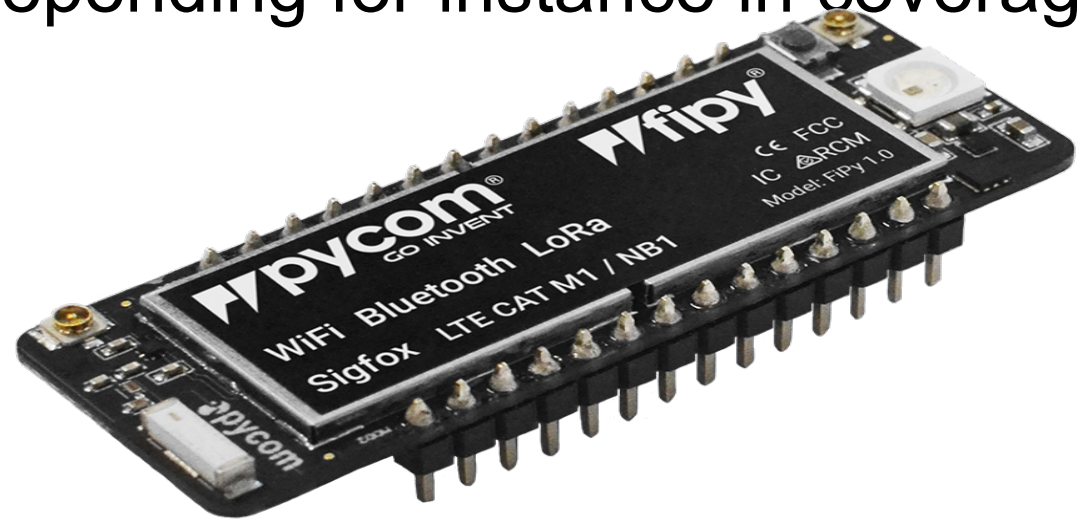
- Protection from interference.
- Standard based, will lead to great economies of scale
- Operator Managed, branding.
- Rich Ecosystem.

Disadvantages

- 2G based solutions are being discontinued in many countries.
- LTE based solutions might not be available in many countries for several years.
- Higher power consumption.
- Might be overall more expensive.
- Recurring per device cost.
- Reliance on a third party.

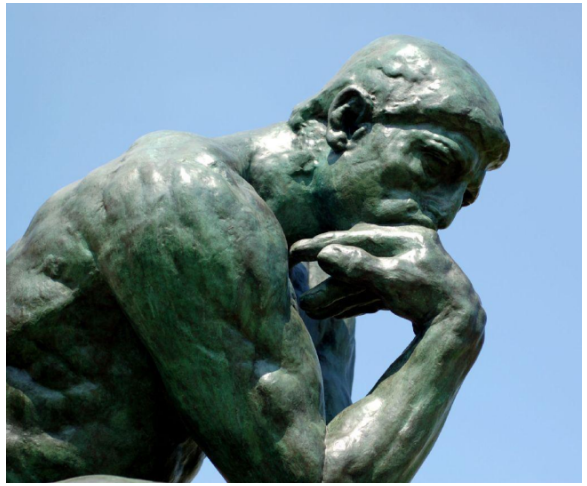
Hybrid Solutions

- Some vendors are offering modules that support cellular IoT solutions as well as LPWAN ones.
- This opens up the possibility of building a LPWAN network now, with the prospect of migrating to an LTE-M or NB-IoT one in the future or even building from scratch a hybrid network in which devices can connect to several networks, depending for instance in coverage or cost.



Factors to consider

- Availability of unlicensed frequencies and degree of occupancy
- Availability of service providers for different solutions
- Number of devices to be deployed
- Number and frequency of messages
- Minimum latency
- Maximum payload
- Battery duration
- In-house expertise



Smart City Applications

Smart metering: Electricity, Gas, Water

Smart Parking

Environment Monitoring

Air quality: Particulate matter, Atmospheric gases, Ozone level

Noise

Meteorological Data

Insect and pest control

Smart City Applications

- Public Transportation Management
- Parking space availability
- Facility Management
- Waste Management
- Vehicle tracking
- Road Traffic Monitoring and management
- Home Automation
- Safety: Street Lighting, Abnormal noise reporting, Gunshot detection, Infrastructure condition reporting
- Flooding war**ning**

Water Management Applications

Water distribution maintenance
Water saving: In most countries, 20-25% of the fresh water produced is lost due to leakages in the public water network.

Waste water treatment, drainage and sanitation

https://smartwatermagazine.com/blogs/parija-rangnekar/how-can-iot-help-water-management-system

Precision Agriculture:

Water, fertilizers and crop control substances saving, Plant Disease control

Sensor technologies link mapped variables to cultivation, seeding, fertilization, herbicide application and harvesting.

Source: CTF Europe – http://www.controlledtrafficfarming.com/ - Pictures from landwise.org.nz & ctfeurope.dk

Precision Agriculture: Rowbot Tractor

Lawn-mower sized autonomous machine that can:

- fertilize the soil
- mulch weeds
- saw crops

https://www.rowbot.com/

E-health applications

- Patients can self-monitor their health issues such as pulse rate, blood pressure, and breathing rate by wearing smart devices which are capable of transmitting all these real time data to health care centers or the cloud.
- This service also helps to reduce cost by facilitating the patients to stay at home without going to hospitals.

E-health applications

- Remote patient monitoring applications allow measurements from various medical and non-medical devices in the patient's environment to be read and analyzed remotely
- Chronic disease management
- Elderly monitoring
- Alarming results can automatically trigger notifications for emergency responders
- Dosage changes can also be administered based on remote commands

Industrial Applications: Industry 4:0

- Interconnected smart devices with the ability to communicate, the cloud paradigm and data analytics led to the concept of Industry 4.0
- A shift from automated manufacturing to intelligent manufacturing:
  - Decentralized
  - Automated
  - Controlled via interdependence

Industry 4.0

Source: **Proposal of an automation solutions architecture for Industry 4.0, researchgate.net**

Industrial Applications: capabilities

- Asset Optimization
- Production Integration
- Smart Monitoring
- Remote Diagnosis
- Intelligent Decision Making
- Predictive and Autonomous Maintenance
- Advanced Robotics

Industrial Applications: Examples

- Environmental information
- Emergency Information
  - Smoke detection
  - Fire Alarm
  - Excessive Vibration
  - Specific equipment parameters
- Operation and Maintenance
  - Work Order
  - Maintenance record
- 3D Printing and Additive Manufacturing

Source: **Proposal of an automation solutions architecture for Industry 4.0**

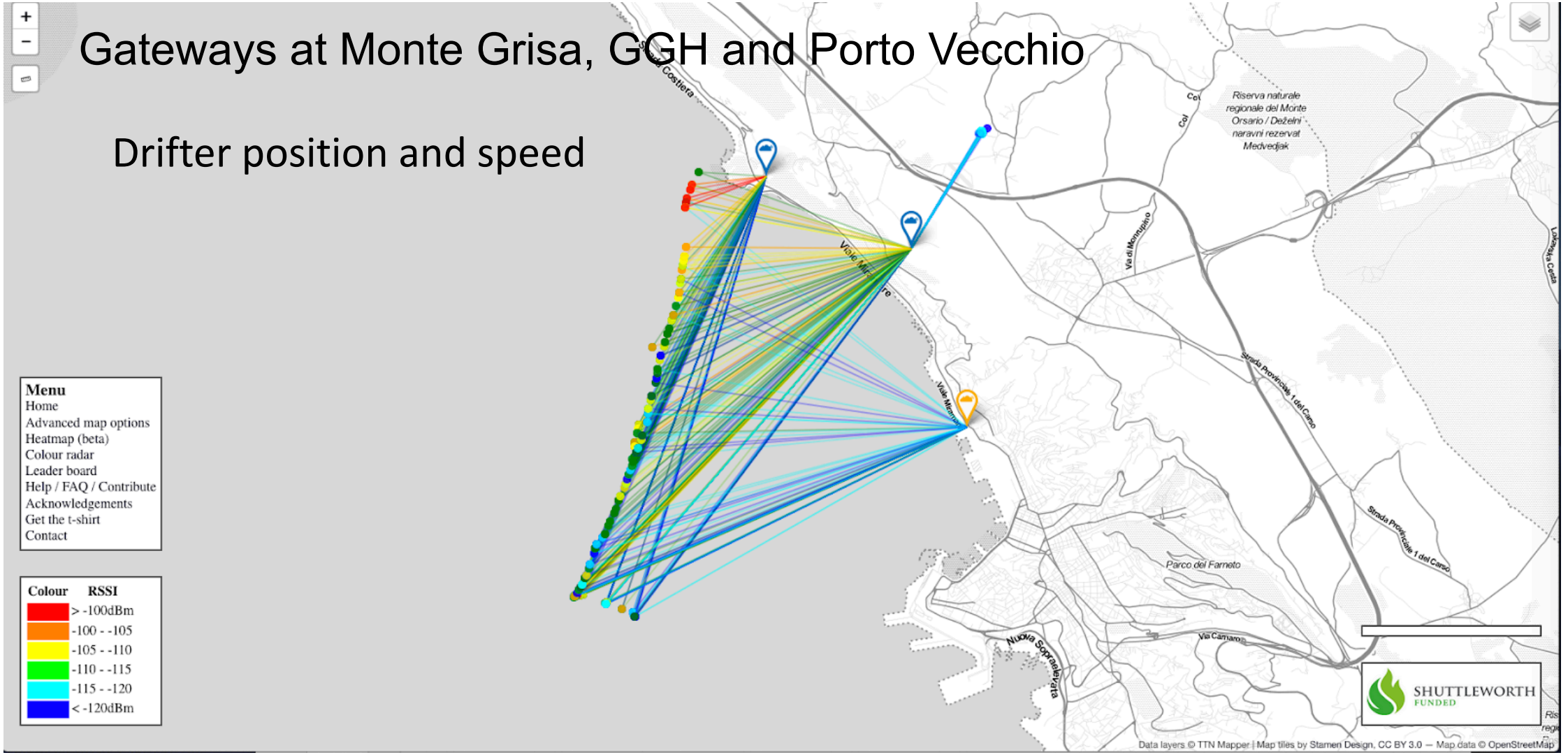
Transportation and Logistic Tracking

https://img.en25.com/Web/ArdenMediaCompanyLLC/%7B8f85009c-fbb1-40d0-96ea-d16f8f54b8ef%7D_EIoTI_July_2019_LPWA.pdf

Measuring Marine variables from a buoy

Environmental parameters are being transmitted by cellular modems
Using LoRa allows saving in recurring costs and increasing the range

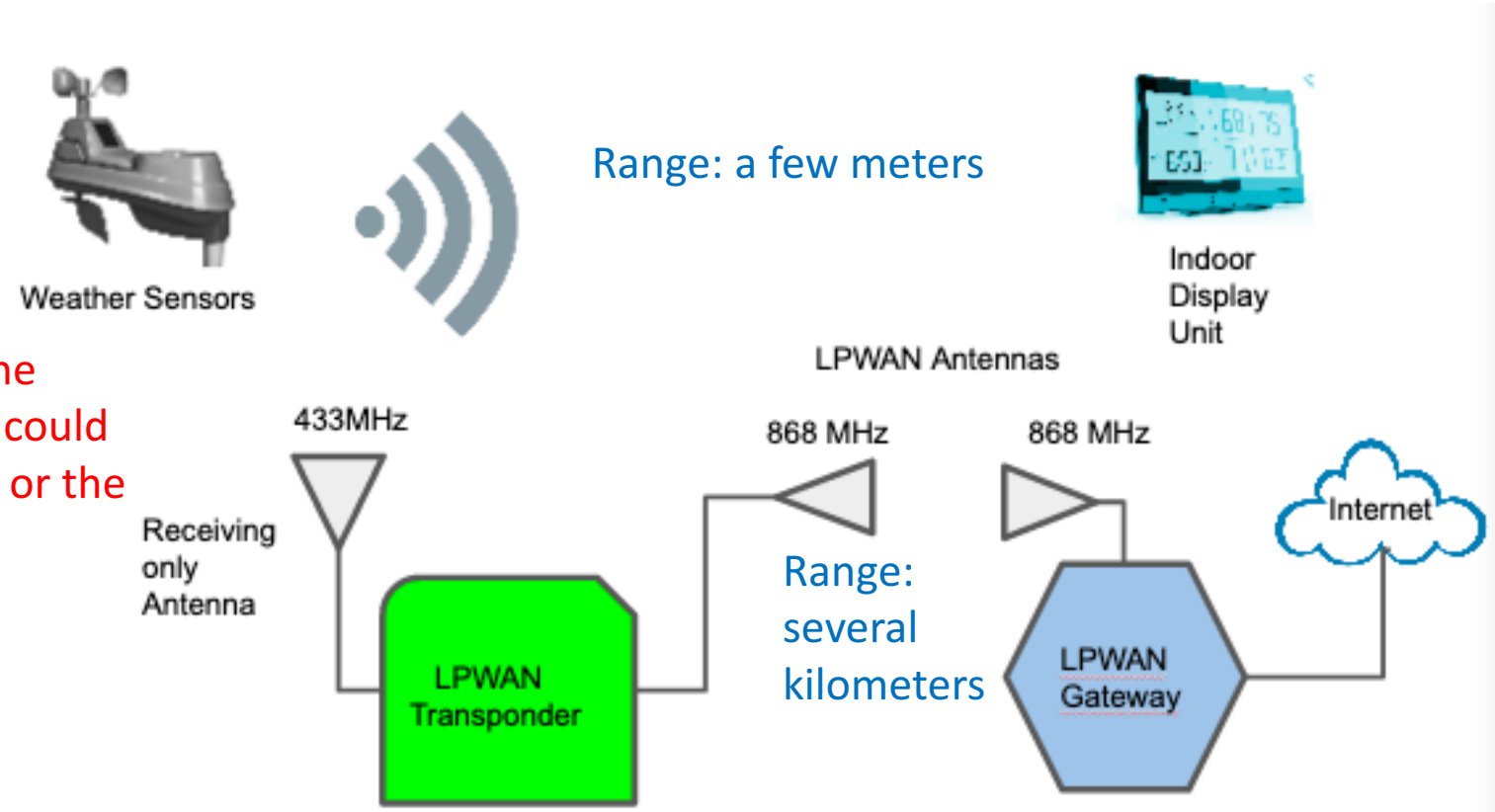
Measuring Marine variables with a drifter



Environmental data in remote locations

- Monitoring environmental parameters and effects in remote locations is of increasing interest due to the rapidly changing global climate and the world in general.
- Parameters like temperature, pressure, water levels, snow levels and seismic activity have significant effects on applications such as green energy (wind and hydro power), agriculture, weather forecasting and tsunami warnings.

Low cost “transponder”, 433 to LoRa



No tampering with the weather station that could affect the calibration or the warantee

Open Source design, code published in Github:
https://github.com/marcorainone/WsLoraTransponder

10 LoRaWAN Gateways installed in Maputo, Mozambique

Maputo LoRaWAN coverage map
Green spots indicate very strong signal, red ones poor signal.

LoRaWAN Gateway with omnidirectional antenna
Ethernet cable carries both power and data

The Thing Network: GWs installed

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Conclusions

- Some applications of IoT networks were presented in fields like smart cities, agriculture and health
- Industrial applications are so wide ranging that deserve a specific treatment
- Fitting objects with communication capabilities opens up a plethora of yet to be described applications