DNIIT DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

INITIATIVE OF THE EXCELLENCE - INVESTMENT FOR THE FUTURE

# DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

# Smart Campus of Danang


Fabien Ferrero, Fabien.Ferrero@univ-cote-azur.com : **Smart Campus UCA Chair**

Nguyen Thi Anh Thu, *anhthu01@gmail.com*: (DNIIT) : **General SmartCampus Chair**

Le Quoc Huy, *lequochuy.dut@gmail.com* : **DUT Chairman**

Nguyen Thi Khanh Hong, *khanhhonghk@gmail.com*: **UTE Chairman**

Huynh Ngoc Tho, *hntho@cit.udn.vn*: **CIT Chairman**


D BACH KHOA DANANG

AUF Agence Universitaire de la Francophonie Asie-Pacifique

UTE

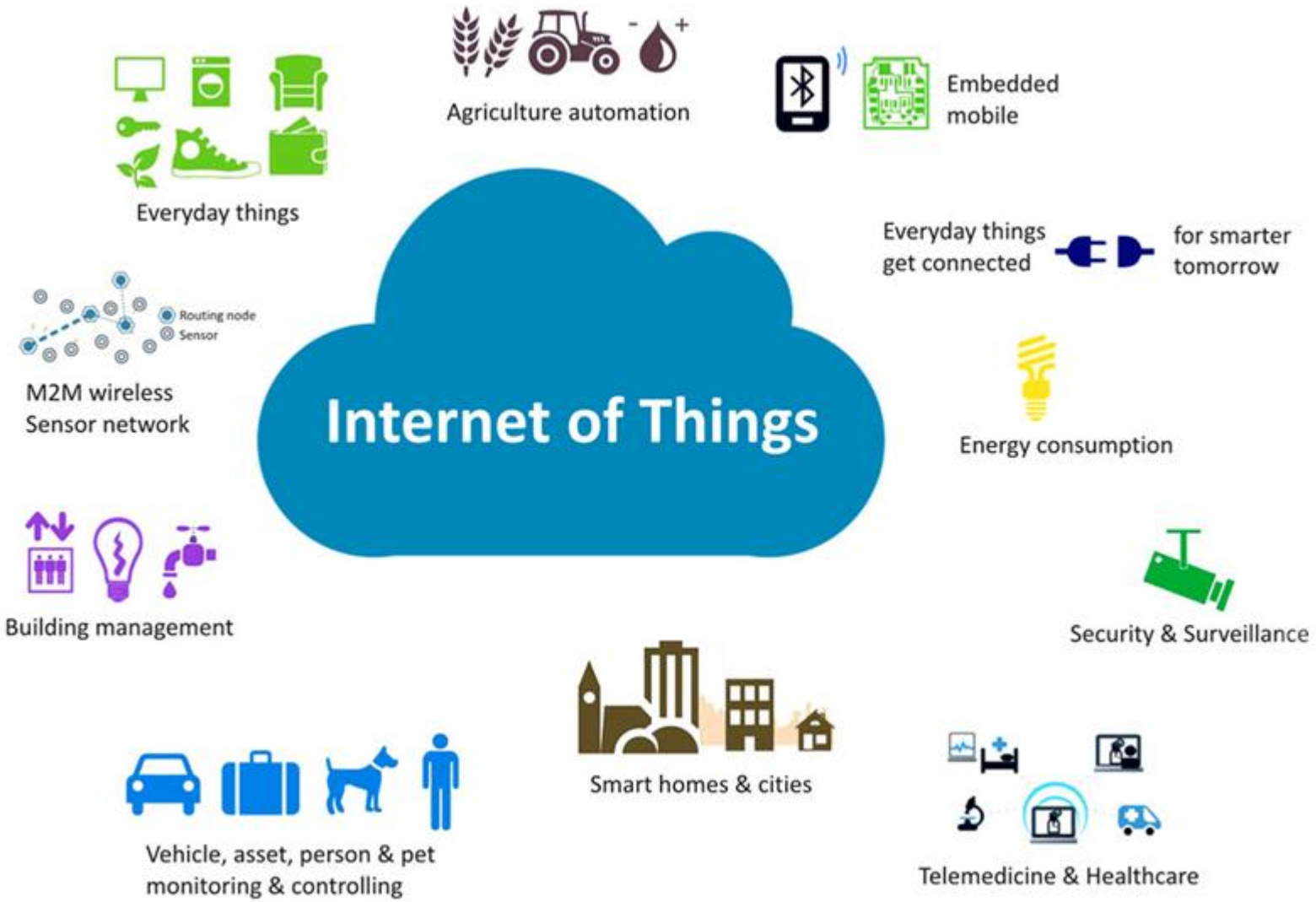
CIT

UNIVERSITÉ CÔTE D'AZUR

# Outline

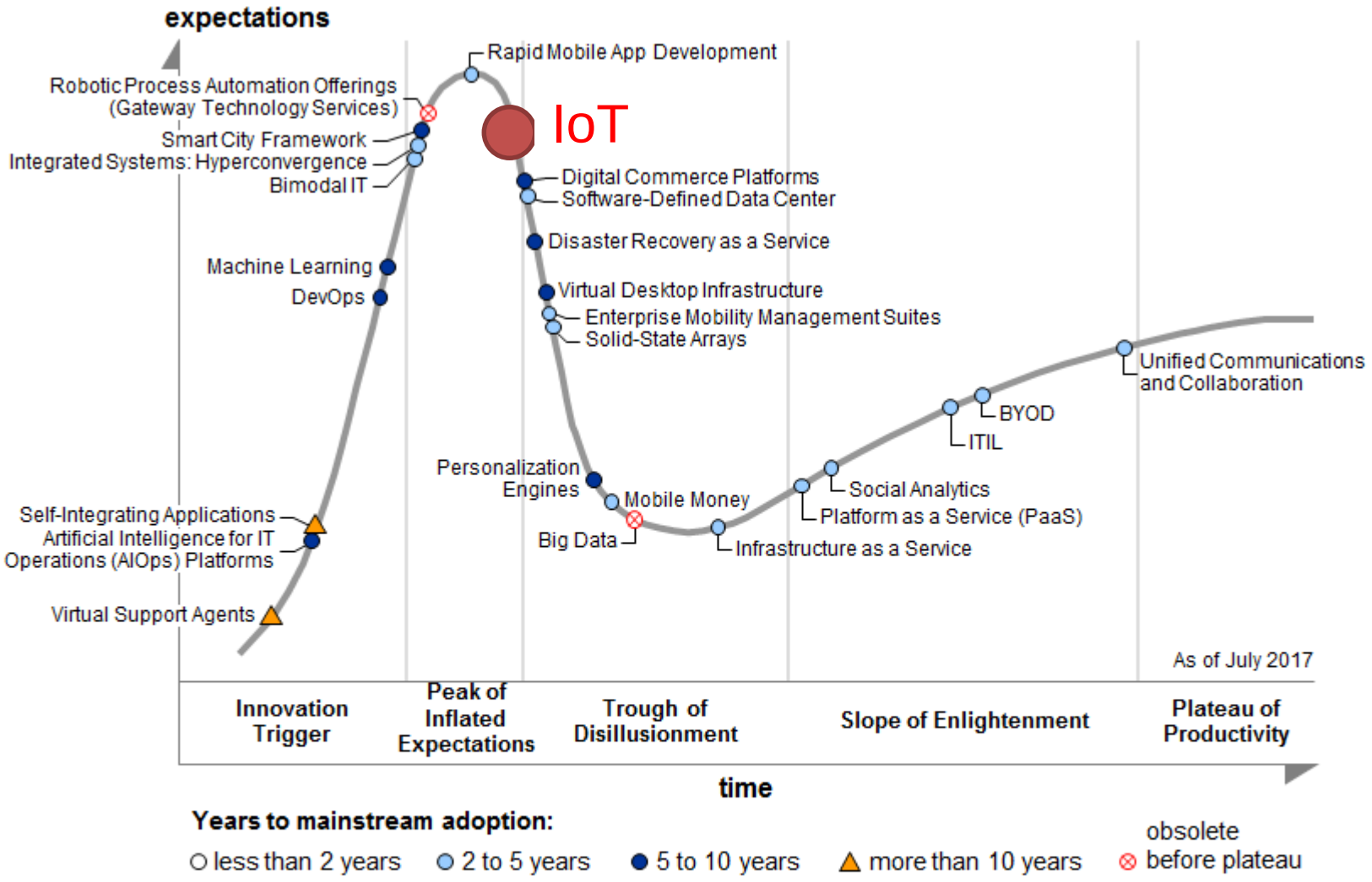
- LP-WAN motivation
- SMART CAMPUS objectives
- Next Smart Campus Campaign

# IoT opportunities : Potential market



# IoT opportunities : Potential market

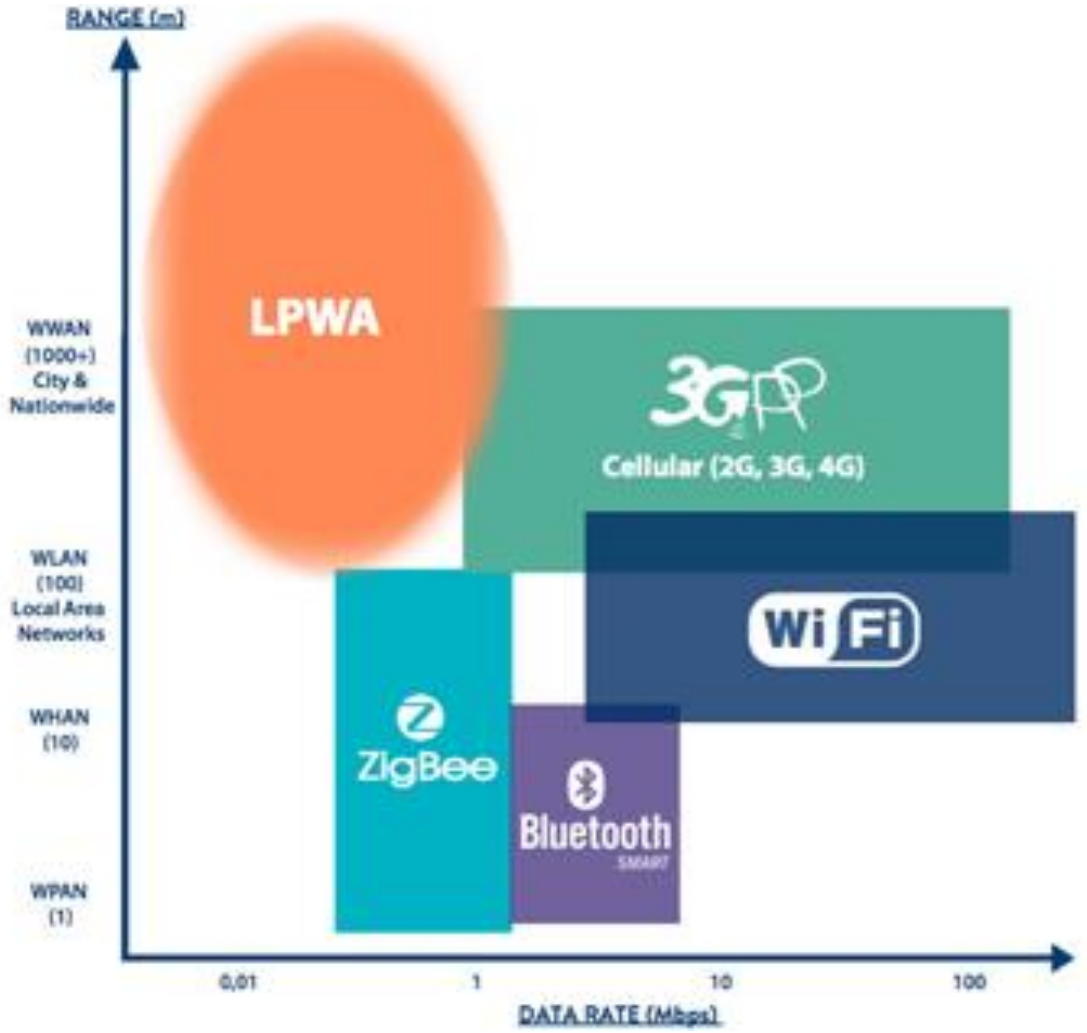
# IoT opportunities : Hype cycle



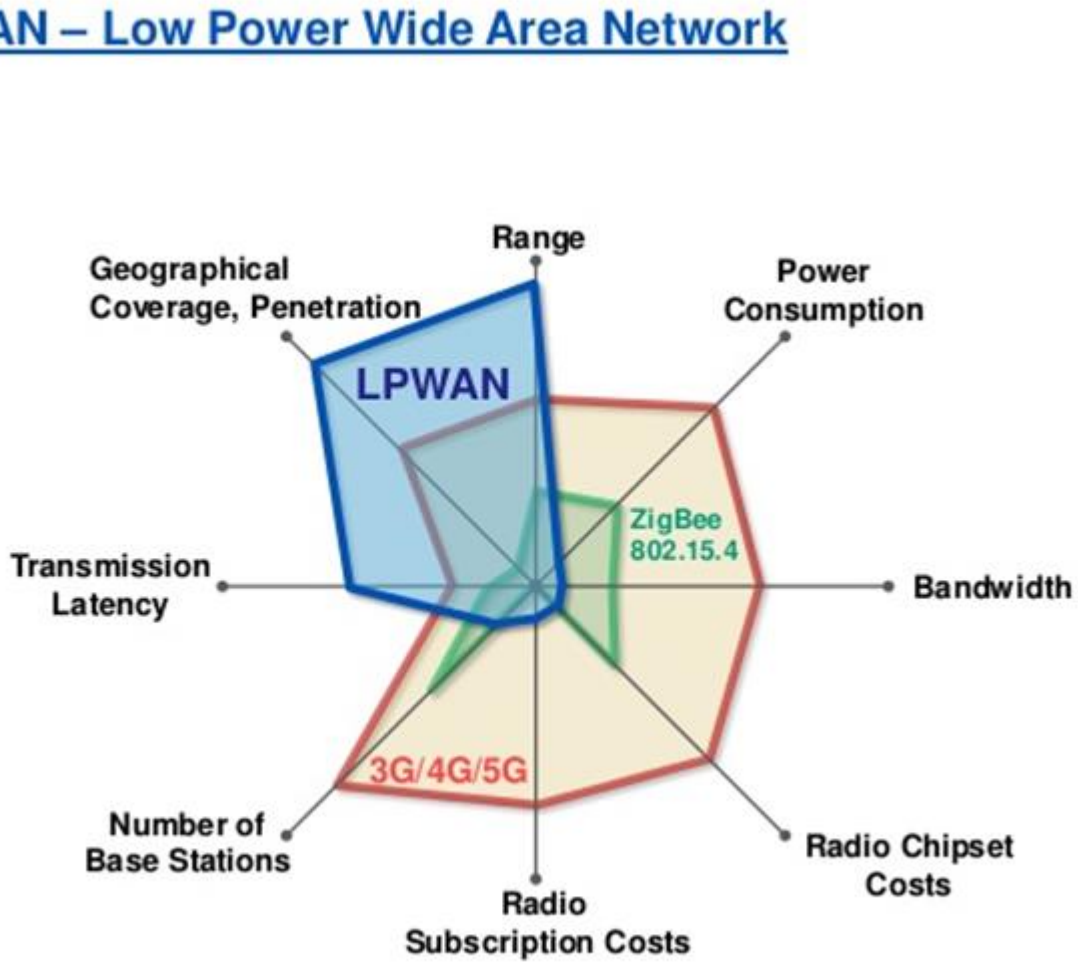
# LP-WAN technologies opportunities

LP-WAN provides new capabilities :

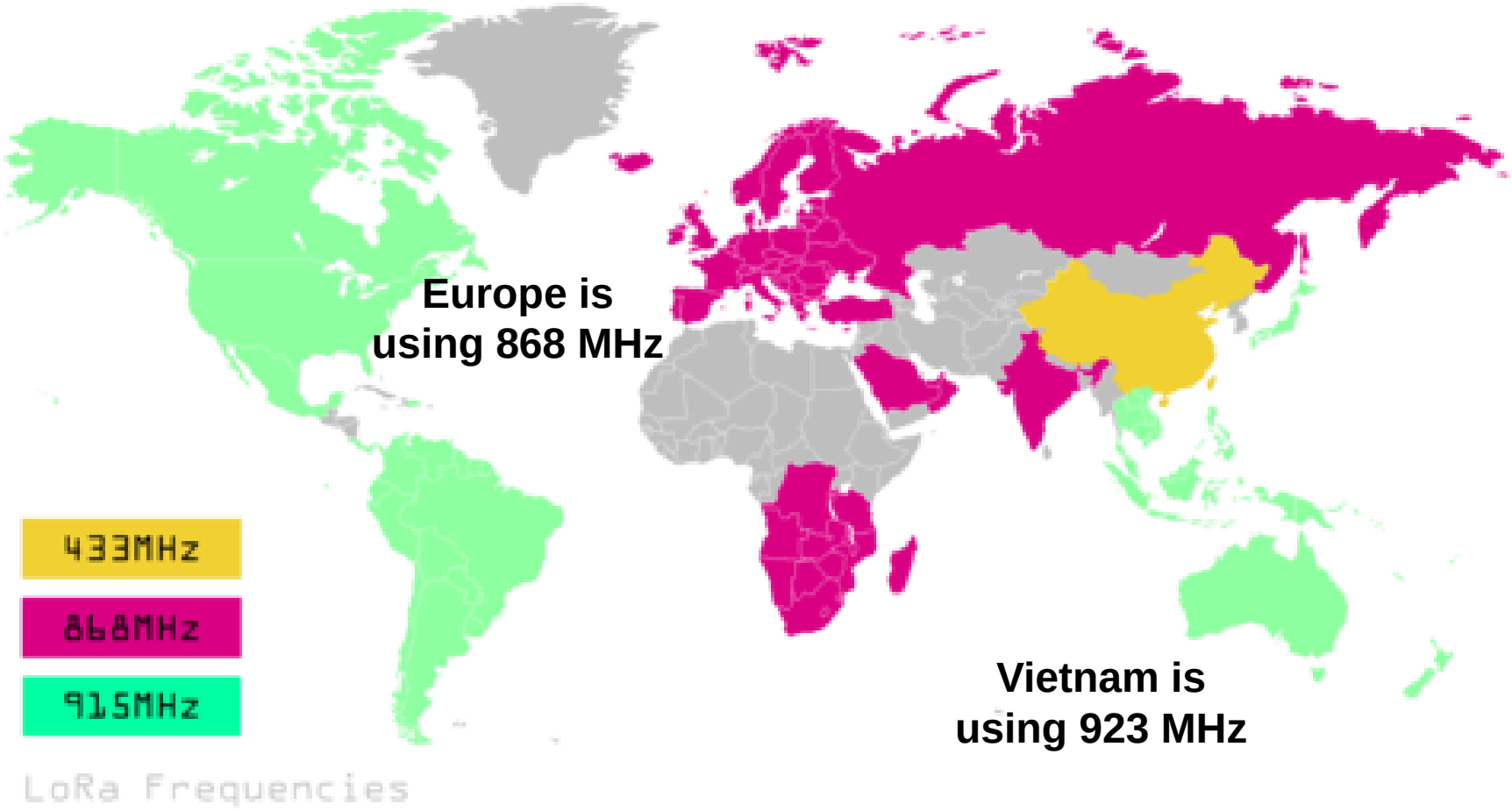
Low-power and long communication range



# LP-WAN technologies opportunities



# LP-WAN ISM bands



# LP-WAN technologies comparison

| | LoRa™ | SIGFOX | NB-IoT 3GPP |
|---|---|---|---|
| | | One network A billion dreams | A GLOBAL INITIATIVE |
| Range (km) | 10km (suburban)<br>3-6km (urban) | 30km (Rural)<br>10km (urban) | |
| Frequency Band (MHz) | Sub GHz (ISM) | 868-900MHz (ISM) | Licensed LTE bands |
| Max. Coupling Loss | 155dB | | 164dB |
| Modulation type | Chirp Spread Spectrum (CSS) | Ultra narrow band / GFSK / BPSK | LTE - OFDMA / SC-FDMA |
| Bandwidth | 125 – 500 kHz | 100 Hz | 180 kHz |
| Datarate | 300 bps – 50 kbps | 100 bps | Up to 250 kbps (UL) – low latency |
| Max /message / day (Uplink) | Unlimited* | 140 msg/day – 12bytesmax/msg | Unlimited (lice. Spectrum) |
| Max /message / day (Downlink) | Unlimited* | 4 msg/day (8bytes max/msg) | Unlimited (lice. Spectrum) |
| Network density | +++ (ADR) | + | +++ |
| Battery peak current | < 50 mA (14dBm) | < 50 mA (14dBm) | ~300mA (@23dBm) |
| Average sensor autonomy | +++ (ADR) | ++ | + |
| Interference immunity | high | Low | Sensitive to downlink jamming |
| Native payload encryption | Yes | Proprietary | Yes |
| Able to create private networks | Yes | No | No |
| Location (w/o GPS) | Yes | No | M1 only, not deployed(**) |
| Commercial availability | Now | Now | Starting in 2017 |

# LP-WAN technologies comparison

- IoT communication standards

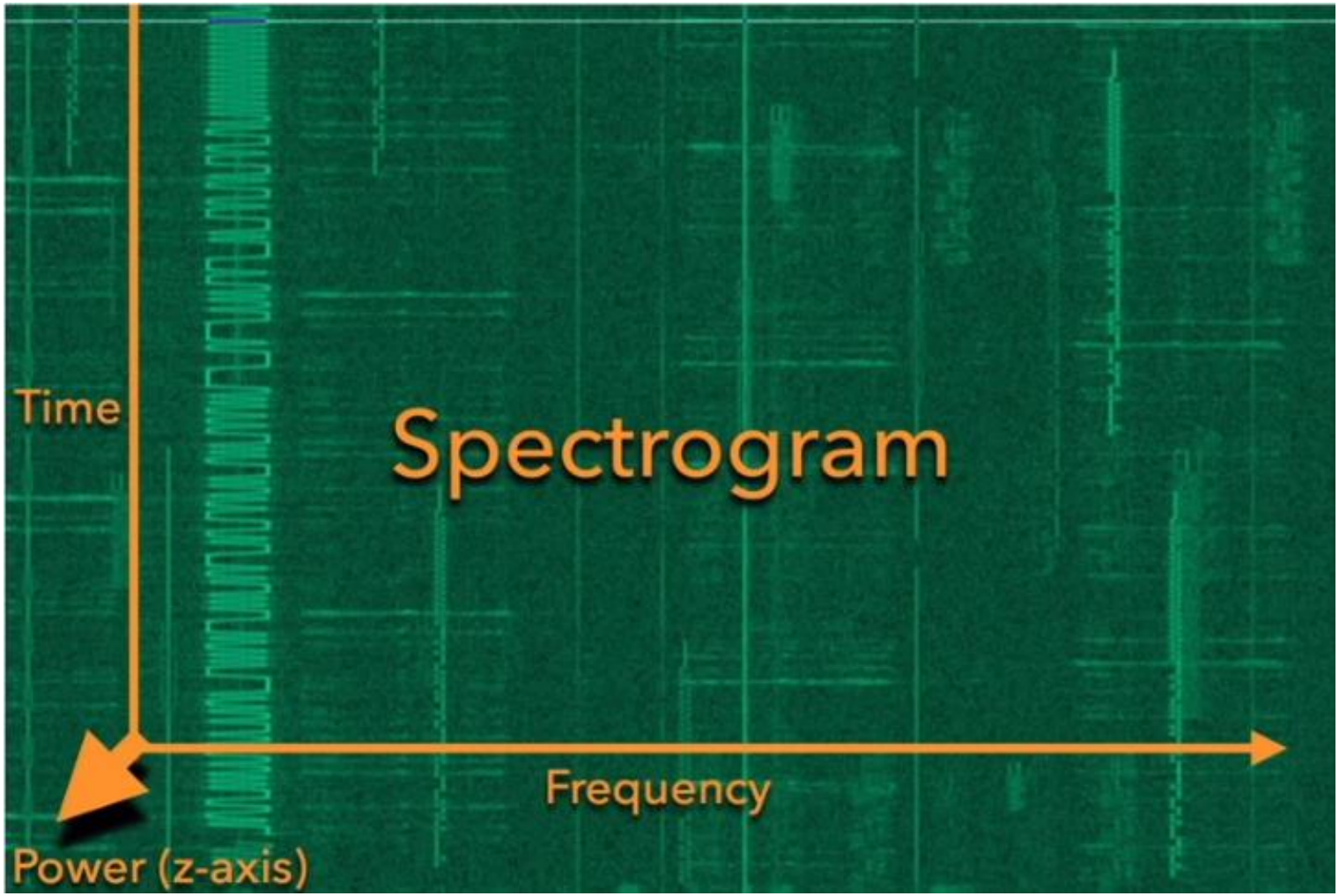

**Frequency :** 2.4GHz
**Data rates :** 20-250 kbps
**Power consumption :**
- Tx : 34 mA
- Rx : 24mA

**Budget Link :** around 100 dB
**Range :** 50m
CC2538 TI

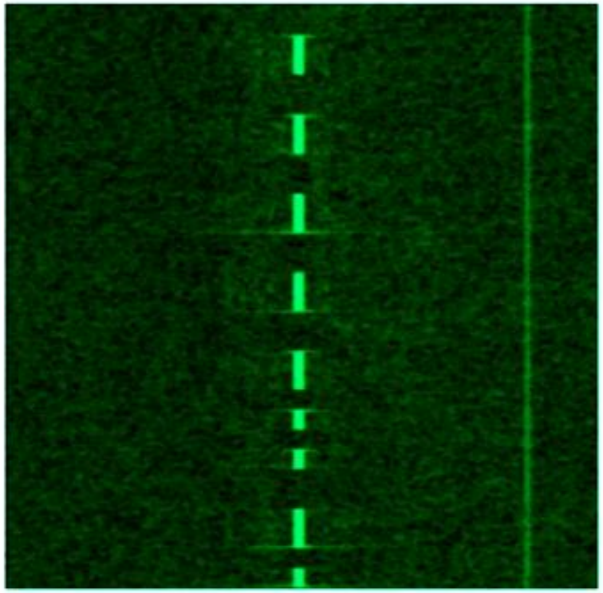

**Frequency :** 868MHz
**Data rates :** 240 bps to 5.5 kbps
**Power consumption :**
- Tx : 28mA
- Rx : 11mA

**Budget Link :** around 150 dB
**Range :** 2 km
SX1272 Semtech

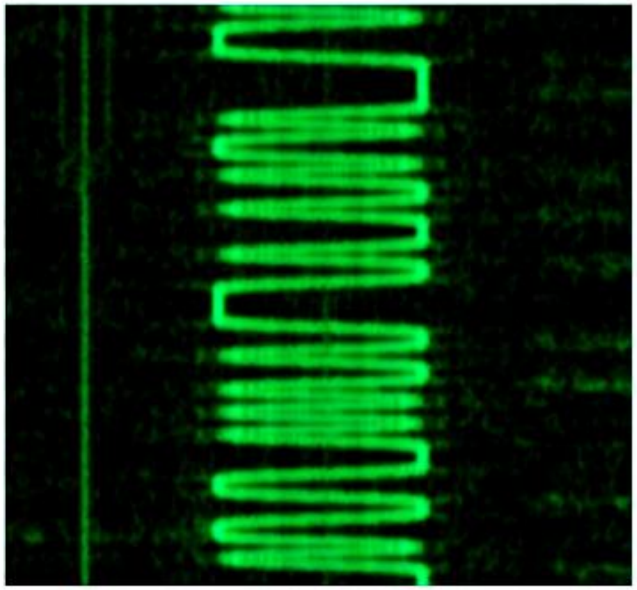
# LoRa modulation : CSS (Chirp Spread Spectrum)



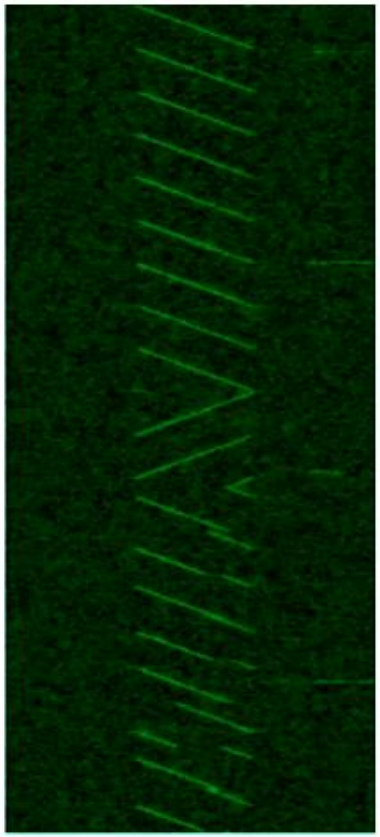
# LoRa modulation : CSS (Chirp Spread Spectrum)



On-Off Keying



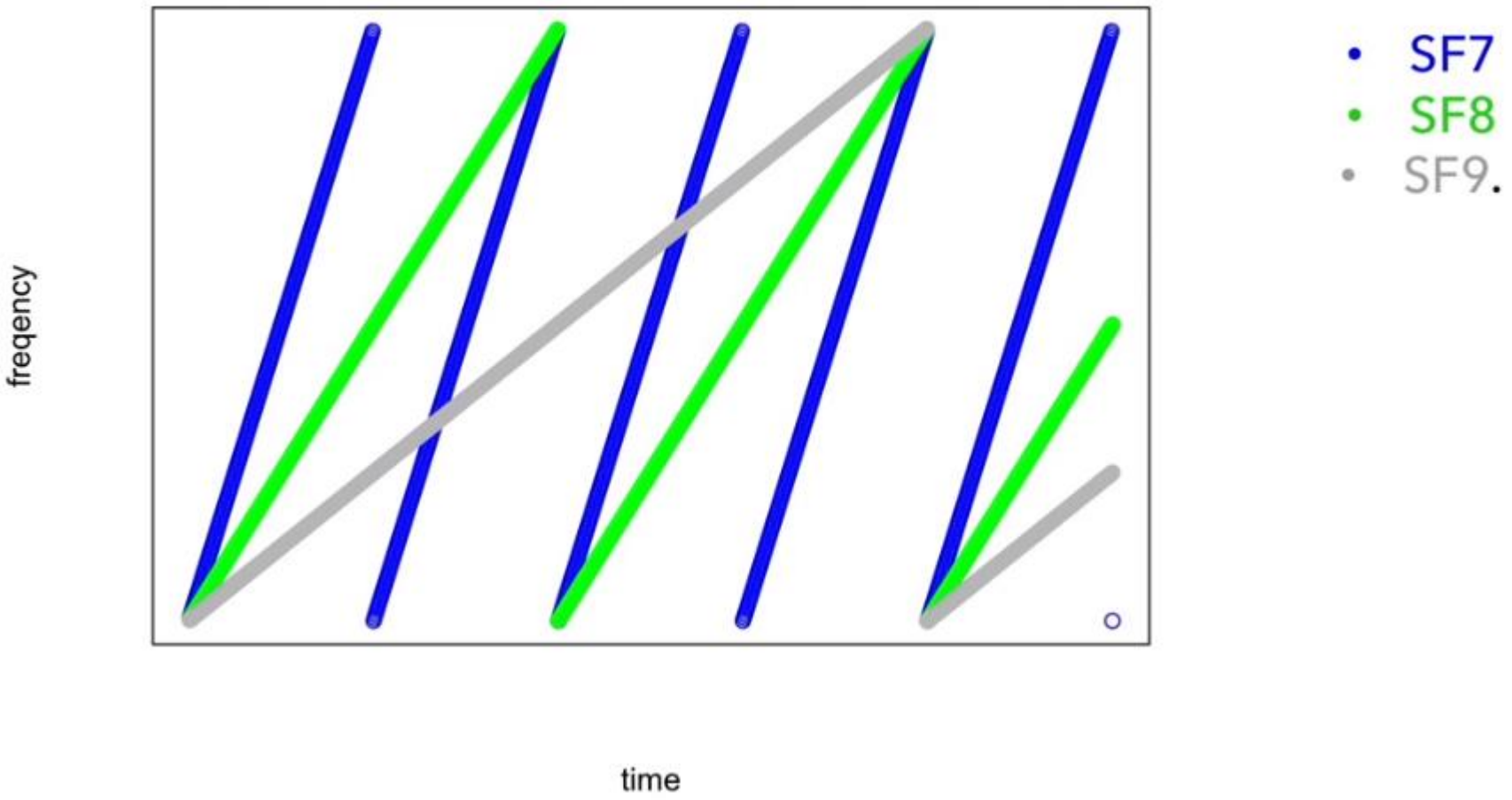
Frequency-shift Keying



LoRa

# LoRa modulation : CSS (Chirp Spread Spectrum)

## Different spreading factors



# LoRa modulation : Spreading factor

- LoRa Spreading factor

$$R_b = SF * \frac{1}{\left[\frac{2^{SF}}{BW}\right]} \; bits/sec$$

Where:

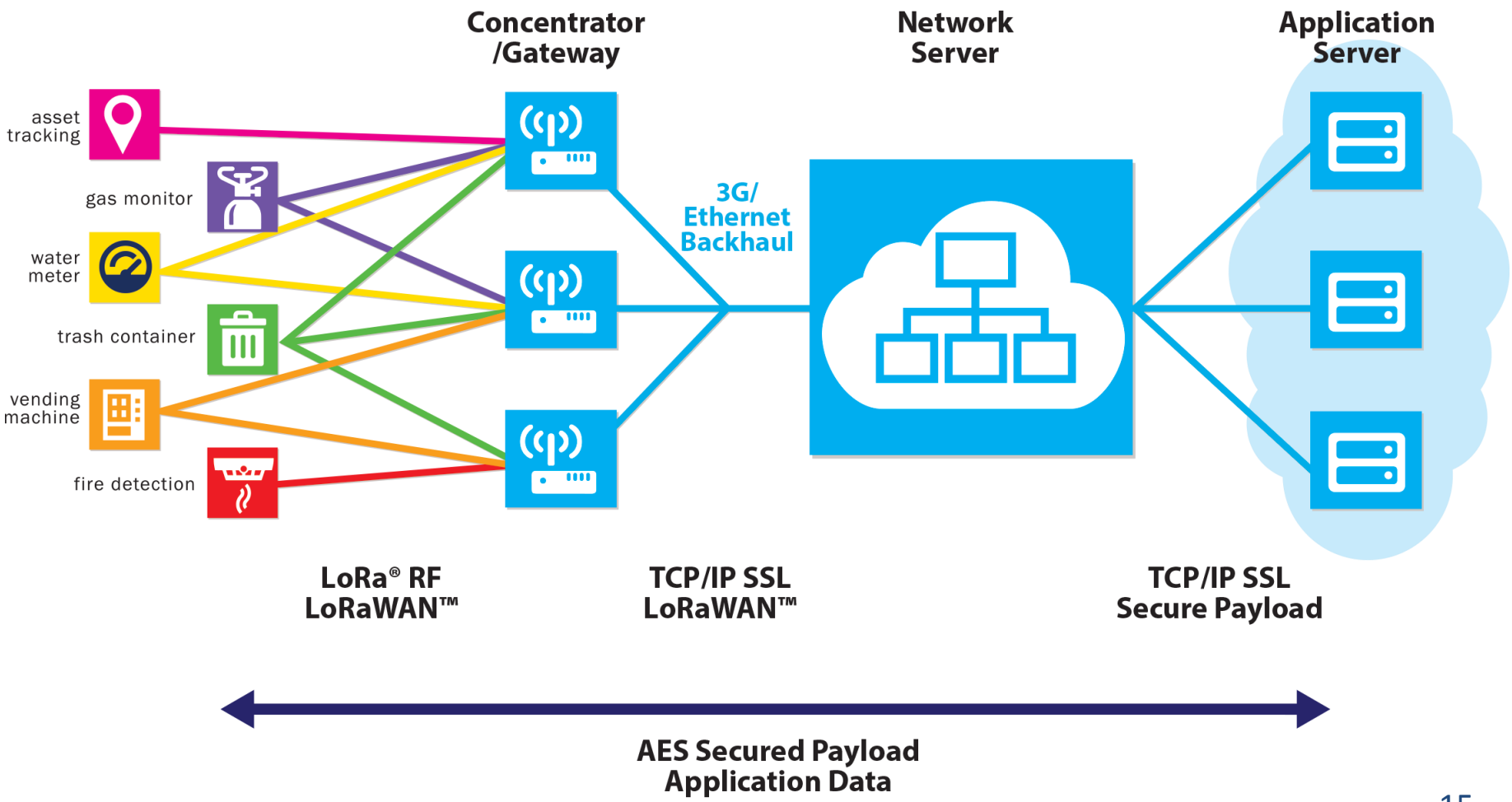
SF = spreading factor (7..12)

BW = modulation bandwidth (Hz)

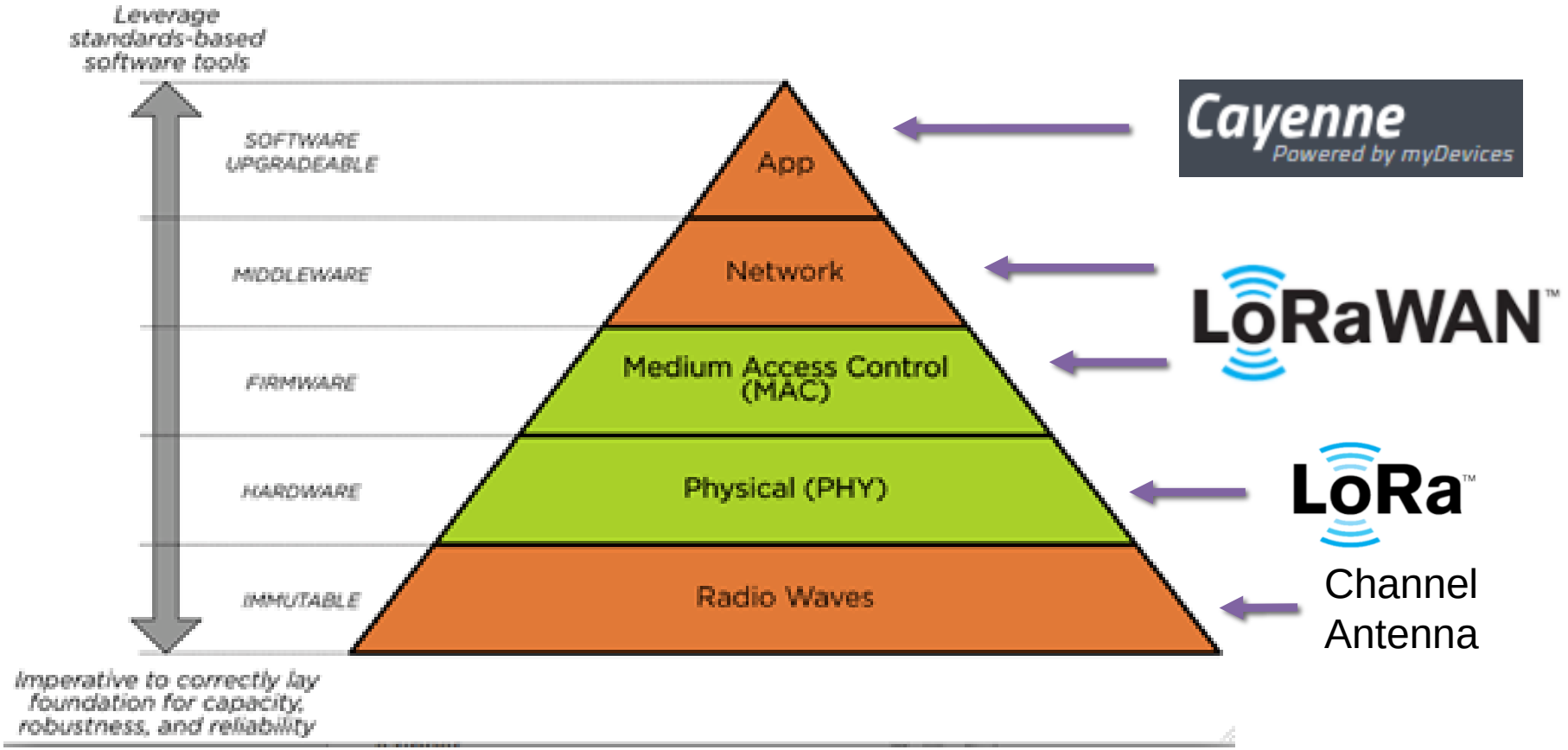
| Mode | Equivalent bit rate (kb/s) | Sensitivity (dBm) | Δ (dB) |
|---|---|---|---|
| FSK | 1.2 | -122 | - |
| LoRa SF = 12 | 0.293 | -137 | +15 |
| LoRa SF = 11 | 0.537 | -134.5 | +12.5 |
| LoRa SF = 10 | 0.976 | -132 | +10 |
| LoRa SF = 9 | 1757 b/s | -129 | +7 |
| LoRa SF = 8 | 3125 b/s | -126 | +4 |
| LoRa SF = 7 | 5468 b/s | -123 | +1 |
| LoRa SF = 6 | 9375 b/s | -118 | -3 |

Table 1: Link Budget Comparison for Narrowband FSK

# LP-WAN network



# LoRa vs LoRaWan



# LoRaWan Class A

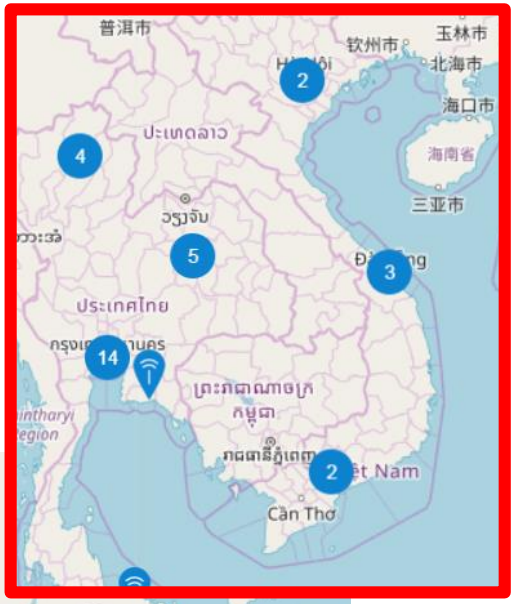
| FRMPayload size (Bytes) | 240 bps SF12/125k | 1 kbps SF10/125k | 5.5 kbps SF7/125k |
|---|---|---|---|
| 4 | ~5 uA | ~2.2 uA | ~1.2 uA |
| 16 | ~7 uA | ~2.5 uA | ~1.3 uA |
| 30 | ~9 uA | ~3 uA | ~1.4 uA |

**Assumptions: Pout = +14 dBm, Average Current**

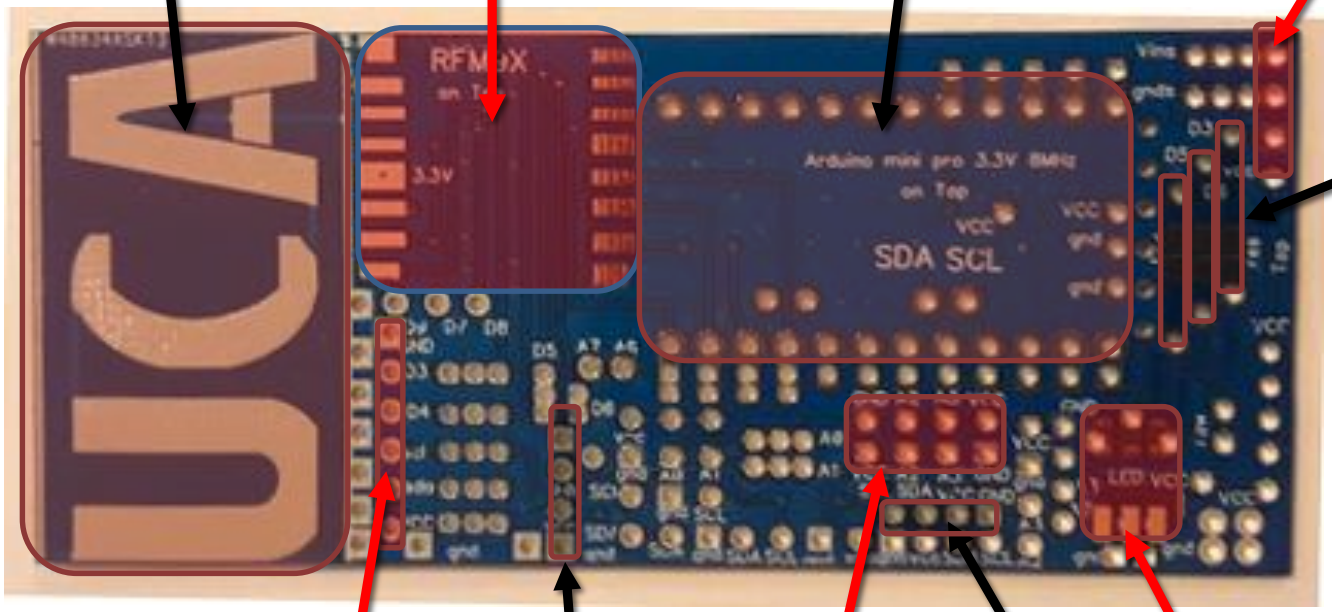
- 10 packets / day
- Sleep current ~1uA (includes the MCU)
- MCU is mostly Off during Tx
- No ACK received
- The energy usage of the 2 unused Rx windows is low (<10%)
- Pout = +14 dBm, IDDTX = 32 mA

# The Things Network : LoRa back end ser ver

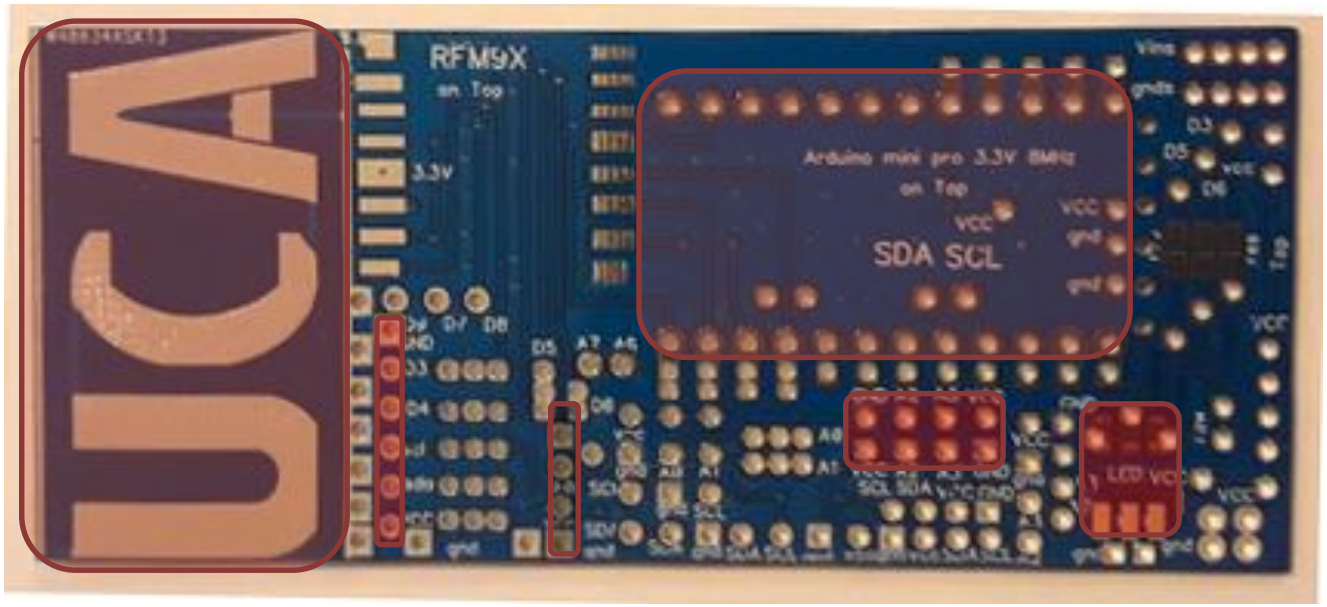
- The Things Network is a global, open, crowd-sourced Internet of Things data network.
- **The Things Network Backend** route messages from Nodes to the right Application, and back
- More than 5000 GWs connected in the world




# UCA IoT Plateform



# UCA IoT Plateform




- Communication up to 15 km
- Power consumption when Transmitting : 100mA on 3.3v
- Power consumption when Sleeping : 10 uA on 3.3V
- With a single AA Lithium battery : Autonomy from 1 to 3 years

https://github.com/FabienFerrero/UCA_Board/

# Outline

- LP-WAN motivation
- SMART CAMPUS objectives
- Next Smart Campus Campaign

# Smart Campus Campaign : General objectives

- Memorandum between on August 22, 2017 between :
  - The University of Danang- University of Science and Technology
  - Danang International Institute of Technology (DNIIT)
- Objective is to promote research toward the **Industrial** Revolutionary 4.0, **Internet of Things** and **Artificial Intelligence**
  - Set up, on UD campuses wireless IoT networks (e.g. LoRa technology) and intelligent services of connected objects.
  - Innovation platform mobilizing students, lecturer-researchers and companies
  - Four campuses of The University of Danang: **DUT, UTE** and **CIT** campus and the headquater of UD.

# Functional objectives

The smart campus main objectives are :

- To provide optimal teaching and learning as well as administration activities in the university through **intelligent services** on the IoT platforms
- **Collaborative** research projects between academic partners of Da Nang University, DNIIT, governmental organizations, and the companies
- **Technology transfer** through direct exploitation by an industrial partner or the creation of startup.

# Technology and innovation challenges

The IoT brings together three major trends in modern society: **mobility**, **automation** and an inextinguishable need for **data**.

Mains challenges are :

- **IoT wireless data** collection platform : large number of nodes connected to the network
- In **real time** a mass of colossal data to be analyzed and processed.
- Study of adequate solutions of the **semantic web** and the processing of "Big Data" allowing the reception, the **filtering** and the classification
- **Intelligent** services and applications using the data collected in a unified information system

# Organisation

| | | |
|---|---|---|
| Academic direction | DNIIT<br>Ass. Prof. F. Ferrero | DUT<br>Dr. Le Quoc Huy |
| Executive boards | Prof. Nguyen Dinh Lam (Vice-director) | Dr. Nguyen Thi Anh Thu |
| | 3 campus chairmans for DUT, EUT and CIT Campus | |
| Commission of jury | Created annually by the management under the proposal of the executive board | |

# Competition of innovative projects

- Annual Call for Proposals
- Development by project groups with the support of **lecturers/researchers**
- Project development : 5 months (beginning of **Nov – April**)
- Jury rankings and awards (board of judge: members from univ., industry, investors,...)
- Awards
  - Lecturer research awards :
  - Student research awards :
    - Best technical project
    - Best innovative idea
    - Most promising project for industrial transfer

# Technical Jury - CRITERIA

| No. | Criteria | Score (Percentage Points) | Notes |
|---|---|---|---|
| 1 | Originality | 20 (20%) | **DOES THE PROJECT SHOW ORIGINALITY?**<br>Has this solution been submitted or awarded in any other competitions/challenges/etc.?<br><br>***Note:***<br>The submitted ideas are strongly encouraged to be original and NOT completely similar to what has been submitted to any other competition/challenge/etc. |
| 2 | Innovation | 30 (30%) | **DOES THE PROJECT SHOW CREATIVITY IN**<br>(a) The approach to solve the problem?<br>(b) The construction or design of the solution?<br>(c) Have you seen the solution or parts of it before in other products/services/etc.? |
| 3 | Feasibility | 30 (30%) | **DOES THE PROJECT SHOW FEASIBILITY TO BE CONDUCTED AND FINANCIAL SUSTAINABILITY:**<br>(a) in term of technical approaches?<br>(b) in term of financial sustainability (including market for the solution, affordable price, potential for business, revenue in comparison to cost?...) |
| 4 | Suitability | 20 (20%) | **DOES THE PROJECT SHOW SUITABILITY TO THE PURPUSE OF SMART-CAMPUS CAMPAIGN?**<br>(a) Does the solution solve a problem on campus?<br>(b) Will this solution greatly benefit those in need (people, administration, services, etc) for long term? |
| **Total Score** | | 100 (100%) | |

# Results 2018 : Lecturer Contest

**First Price : Owlhouse**

*Tran Van Lic, Nguyen Van Thuan, Chau Ngoc, Que, Nguyen Dinh Quy*

*The development of Smart Campus using IoT as case study: System includes electric device control, lighting and motion sensor, fire alert, student attendance management system*


**Second Price : SMART Parking System**

*Vu Van Thanh, Nguyen Quang Quoc, Tran Dinh Loi, Phan Tran Dang Khoa*

*End-to-end parking system based on LoRa technology powered by renewable energy*

**Third Price : EcoLoRa**

*Ngo Dinh Thanh, Pham, Nguyen Phu Hien, Le Loc Minh Phuc*

*IoT eco-gateway for smart campus : Develop an IoT ecosystem gateway in physical layer and application including popular IoT communication standards : MQTT, RF, Z-Wave, LoRa, etc …*

# Results 2018 : Student Contest

**First Price : Wow**

*Le Loc Minh Phuc, Pham Nguyen Phu Hien, Bui Van Khoi, Van Tan Hien*

*Design an IoT LoRa gateway for self-study space management system in a smart campus based on video processing*

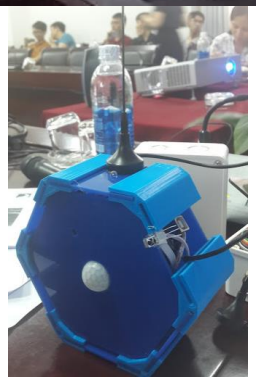
**Second Price : Galaxy team**

*Huynh Van Tien, Huynh Ngoc Tan, Tran, Thanh Hieu, Duong Ngoc* Quoc

*IoT Solution for classroom management with presence detector, screen remotely controlled and light control.*

**Third Price : Tapit**

*Smart control of classroom environment: light, air conditioning and air quality*



# Results : Most promising project for industrial transfer

**EcoLoRa**

*Ngo Dinh Thanh, Pham, Nguyen Phu Hien, Le Loc Minh Phuc*

*IoT eco-gateway for smart campus : Develop an IoT ecosystem gateway in physical layer and application including popular IoT communication standards : MQTT, RF, Z-Wave, LoRa, etc …*

# Outline

- LP-WAN motivation
- SMART CAMPUS objectives
- Next Smart Campus Campaign

# Next Smart Campus Objectives

- Extend projects from Smart Campus to Smart city
- Set-up an open data base using connected objects developed in the frame of the projects
- Highlight student and lecturer projects
- Involve other departments including mechanics, human and social science, economics, marketing …
- Use LoRaWAN network in your campus

# Next Smart Campus Campaign

- ✓ Before **15th of November**, submit the 1-page registration form with a description of your project and team.
- ✓ In November, participate to one of the tutorial organized in your campus, and receive the lora board to start your project.
- ✓ Create a github about your project and send the link to your campus chairman
- ✓ Before the **21st of January 2019**, provide a 3mn video clip describing your project. The 3 best innovative ideas will receive a prize.
- ✓ Semi-final will be organized by each campus (DUT, UTE and CIT) to select the best projects for the final
- ✓ During the **IEEE RIVF Conference** which will be held in Da Nang the 20-22 March 2019, you will present a poster and a live demo. The best projects will receive prizes at the award ceremony.

# Next Smart Campus Objectives

The proposed project shall focus on Smart Campus themes, with extension to Smart City topics. Possible projects, but not limited to, are :

- **DUT** : Smart Building and smart city (Energy saving management, Building security, …)
- **UTE** : Advanced services for e-tourism (e-cultural, e-sports, e-guide …)
- **CIT** : Green technology and e-learning (Energy harvesting, smart teaching …)

# Next Smart Campus Objectives

The proposed project shall focus on Smart Campus themes, with extension to Smart City topics. Possible projects, but not limited to, are :

**Smart Bulding** (Energy saving management, Building security, …), **Smart identification (**Presence management, e-guide, …), **Smart services (**Administrative documentation, Library, Canteen …), **Smart campus life (**e-cultural and e-sports), **Smart Mobility** (bike management, smart parking …), **Smart Security** (safety, fire alert, …)

DNIIT DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

INITIATIVE OF THE EXCELLENCE - INVESTMENT FOR THE FUTURE

# DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

fabien.ferrero@unice.fr

D BACH KHOA NANG

AUF Agence UNIVERSITAIRE DE LA FRANCOPHONIE Asie-Pacifique

UNIVERSITÉ CÔTE D'AZUR