DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

INITIATIVE OF THE EXCELLENCE - INVESTMENT FOR THE FUTURE

DANANG INTERNATIONAL INSTITUTE OF TECHNOLOGY

Smart Campus of Danang

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BACH KHOA DANANG

AUF Agence UNIVERSITAIRE DE LA FRANCOPHONIE Asie-Pacifique

UTE

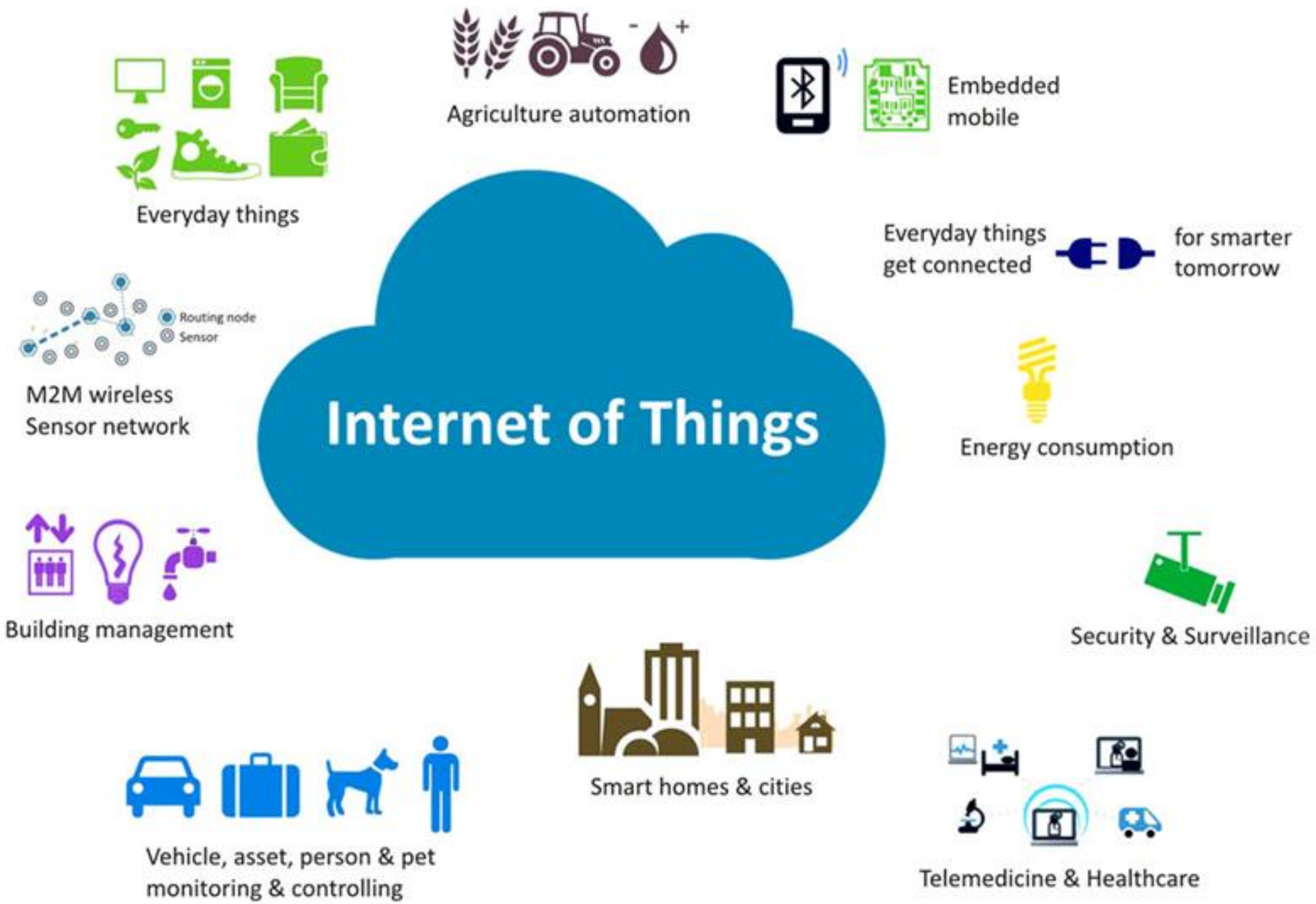
CIT

UNIVERSITÉ CÔTE D'AZUR

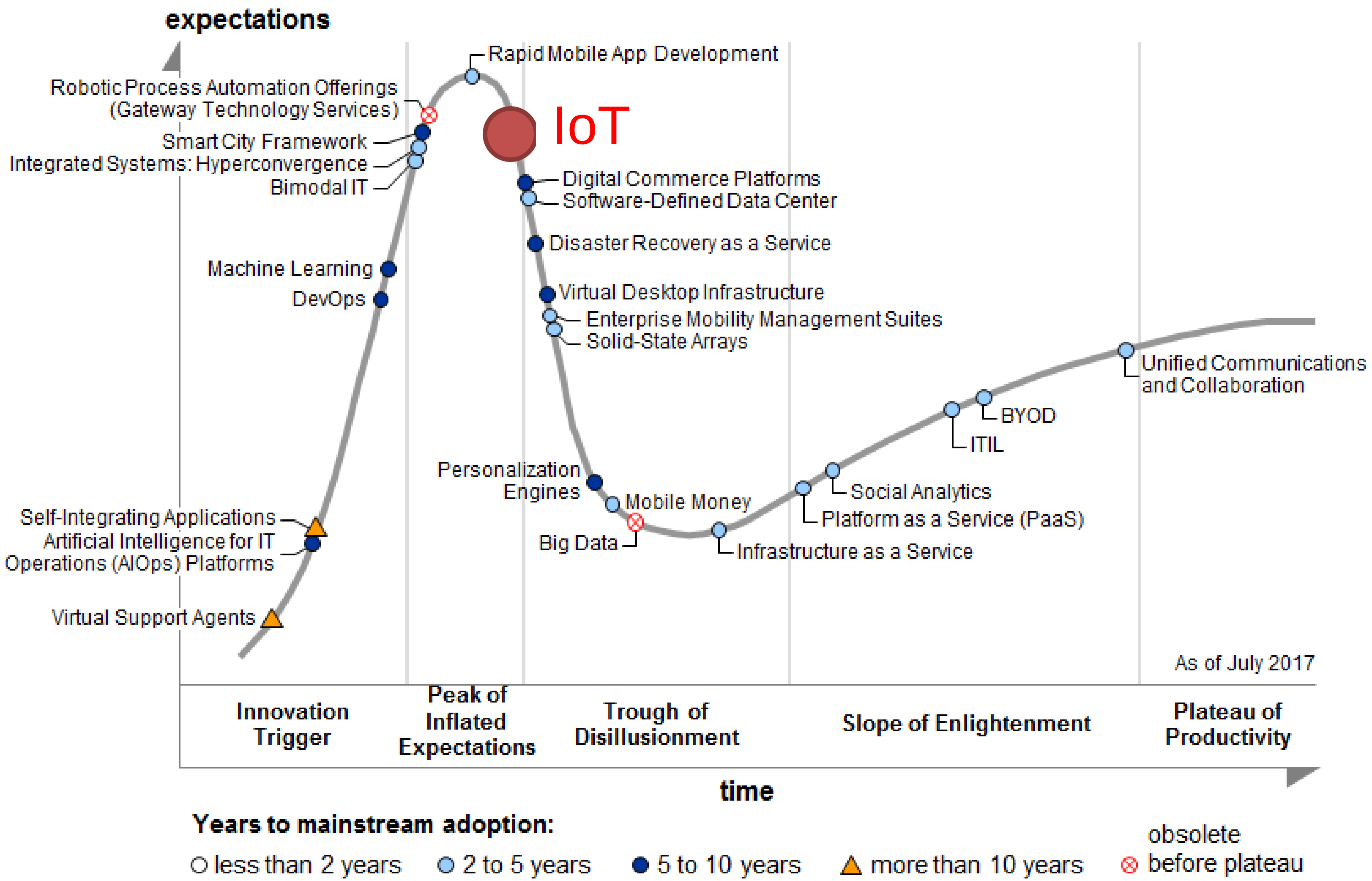
Outline

- LP-WAN motivation
- SMART CAMPUS objectives
- 2018-2019 Smart Campus Campaign

IoT opportunities : Potential market



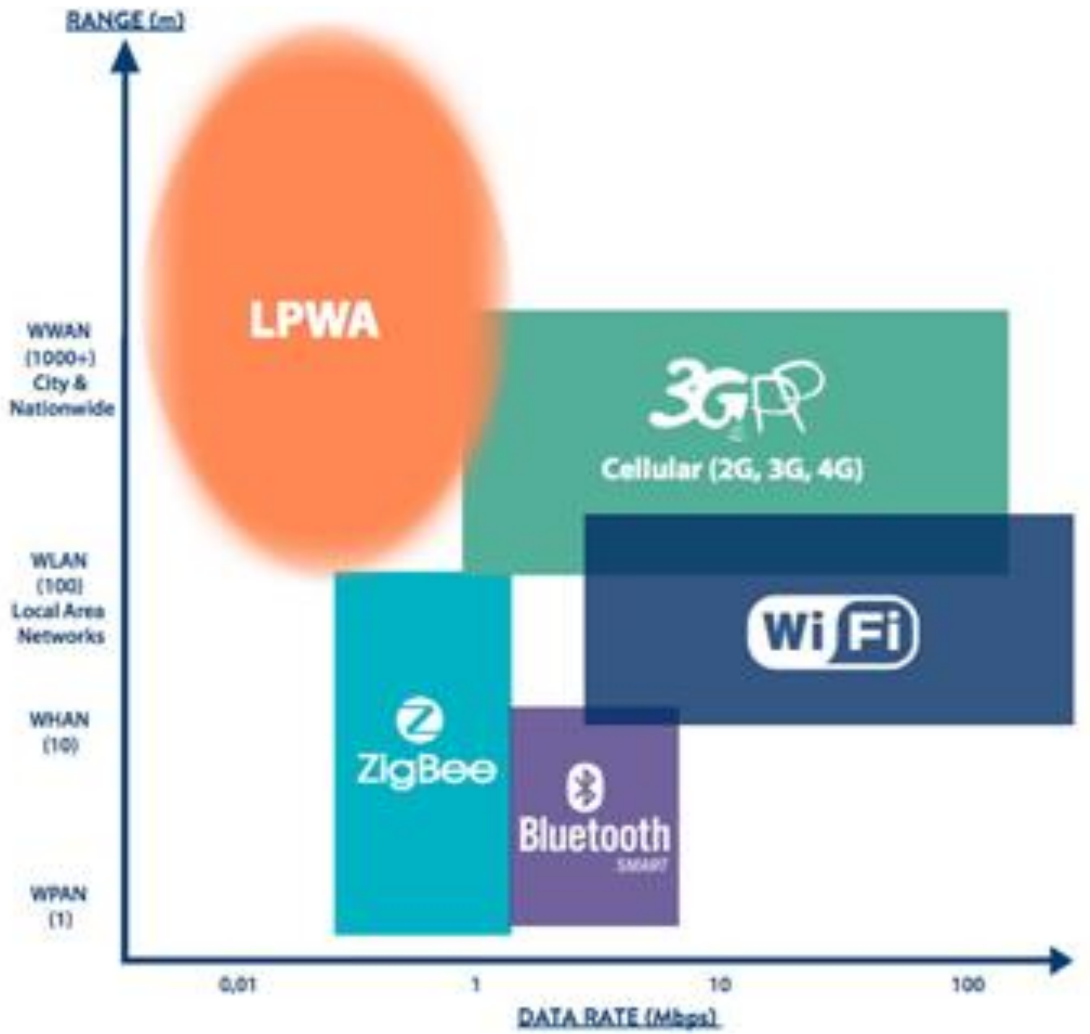
IoT opportunities : Hype cycle



LP-WAN technologies opportunities

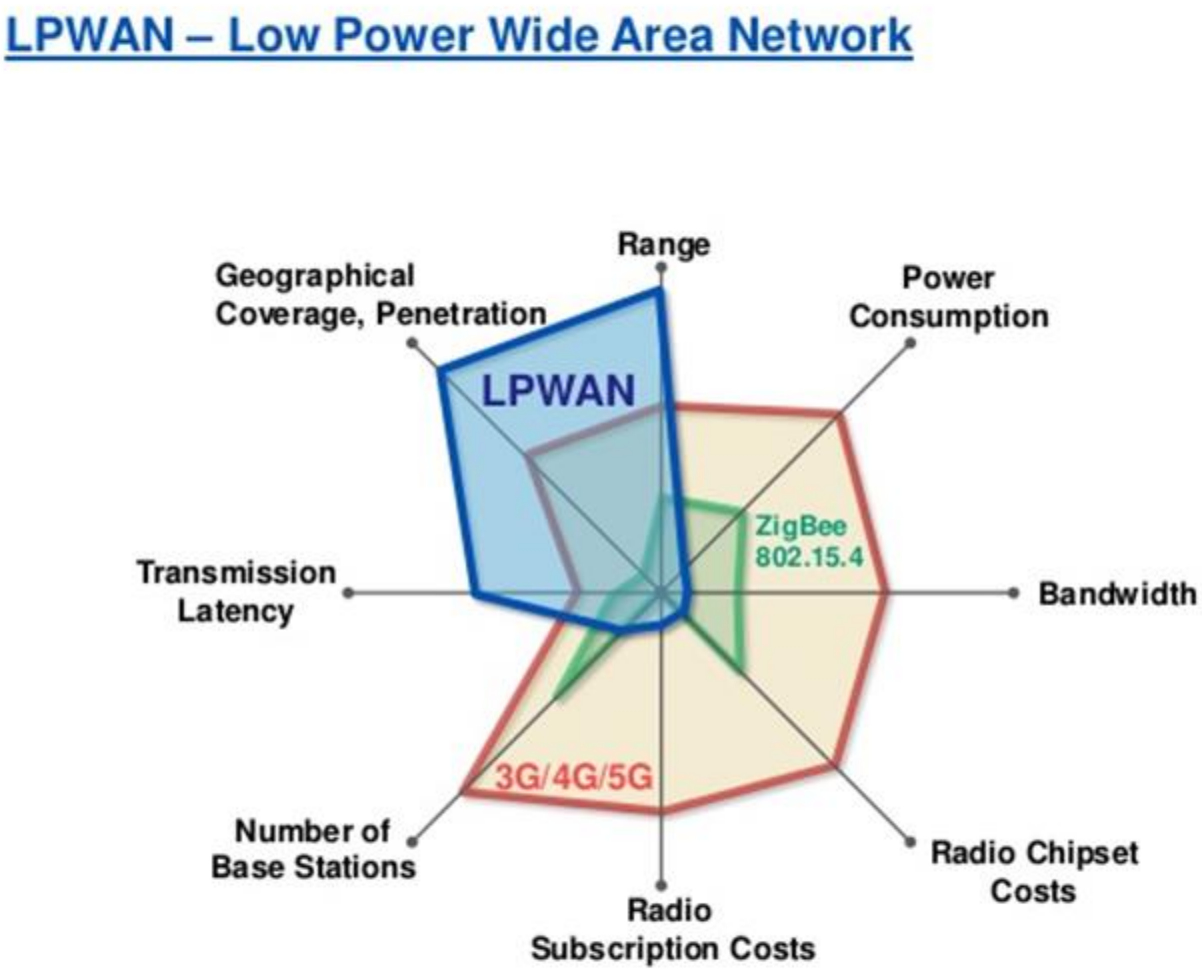
LP-WAN provides new capabilities :

Low-power and long communication range

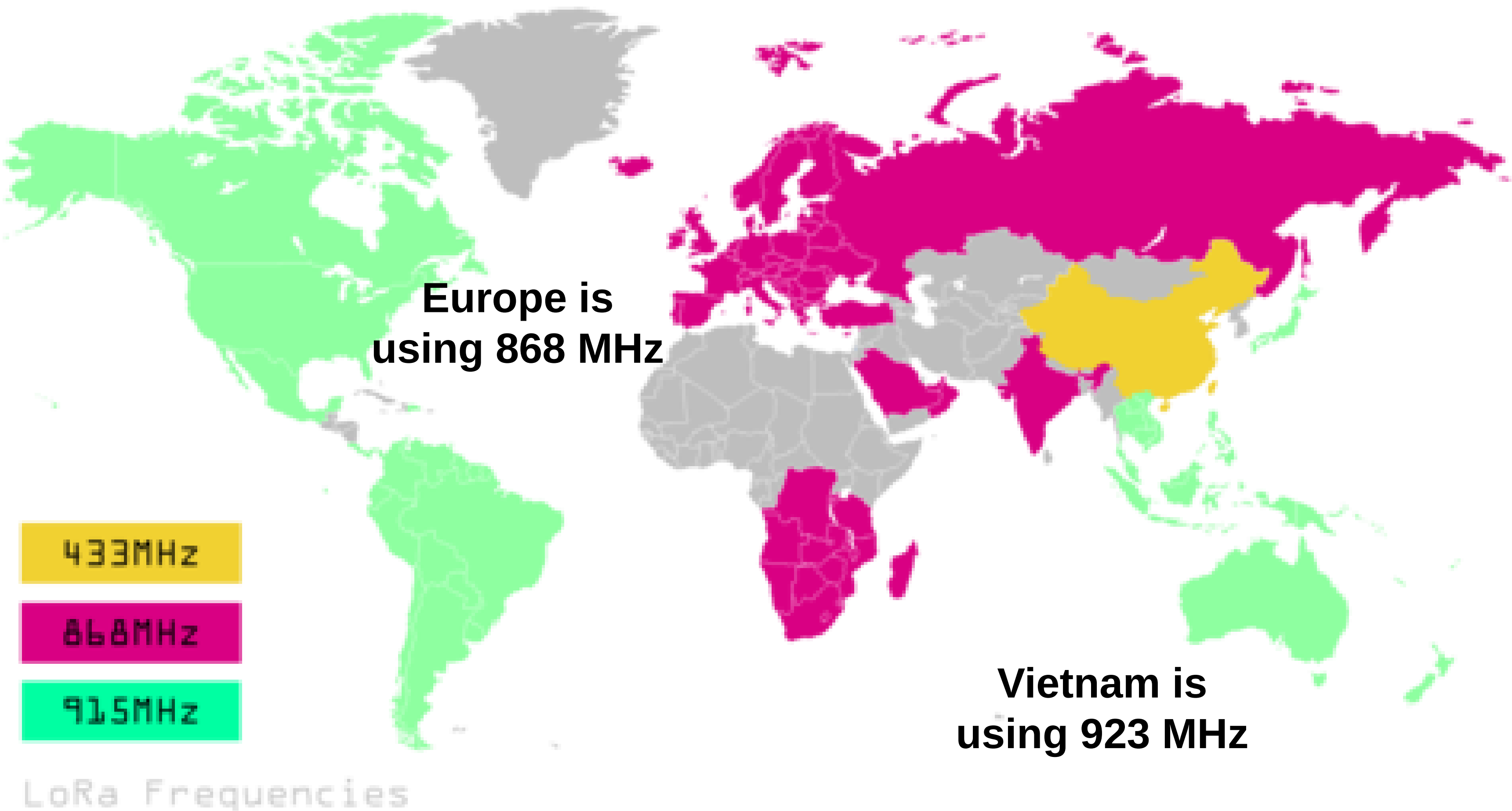


Power 1mW 10mW 100mW

LP-WAN technologies opportunities



LP-WAN ISM bands



LP-WAN technologies comparison

	LoRa	SIGFOX	NB-IoT 3GPP
Range (km)	10km (suburban) 3-6km (urban)	30km (Rural) 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

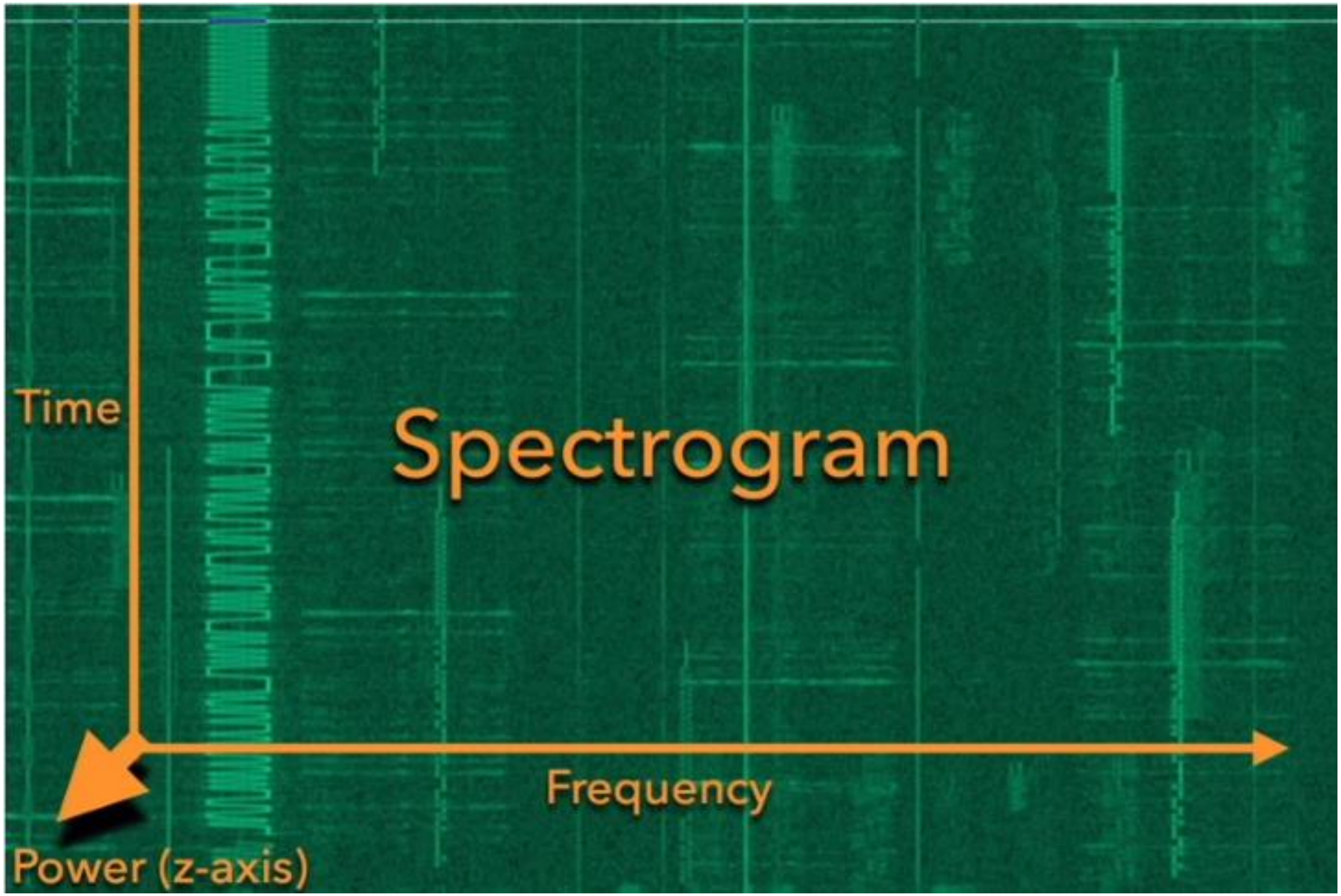
Frequency : 2.4GHz
Data rates : 20-250 kbps
Power consumption :
  - Tx : 34 mA
  - Rx : 24mA

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

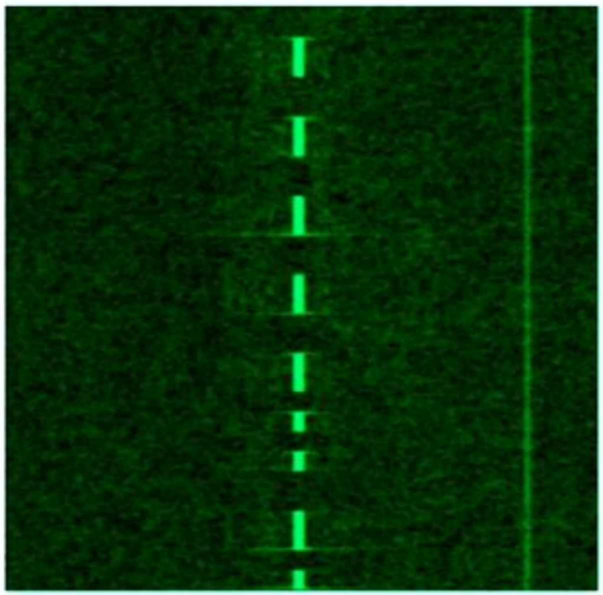
Frequency : 868MHz
Data rates : 240 bps to 5.5 kbps
Power consumption :
  - Tx : 28mA
  - Rx : 11mA

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

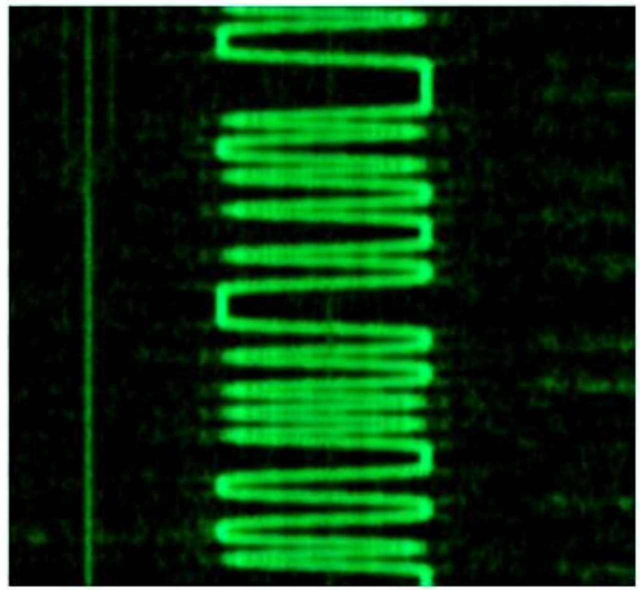
LoRa modulation : CSS (Chirp Spread Spectrum)



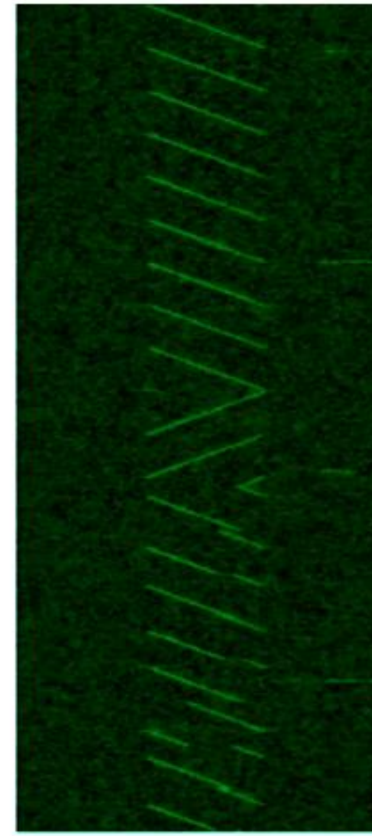
LoRa modulation : CSS (Chirp Spread Spectrum)



On-Off Keying



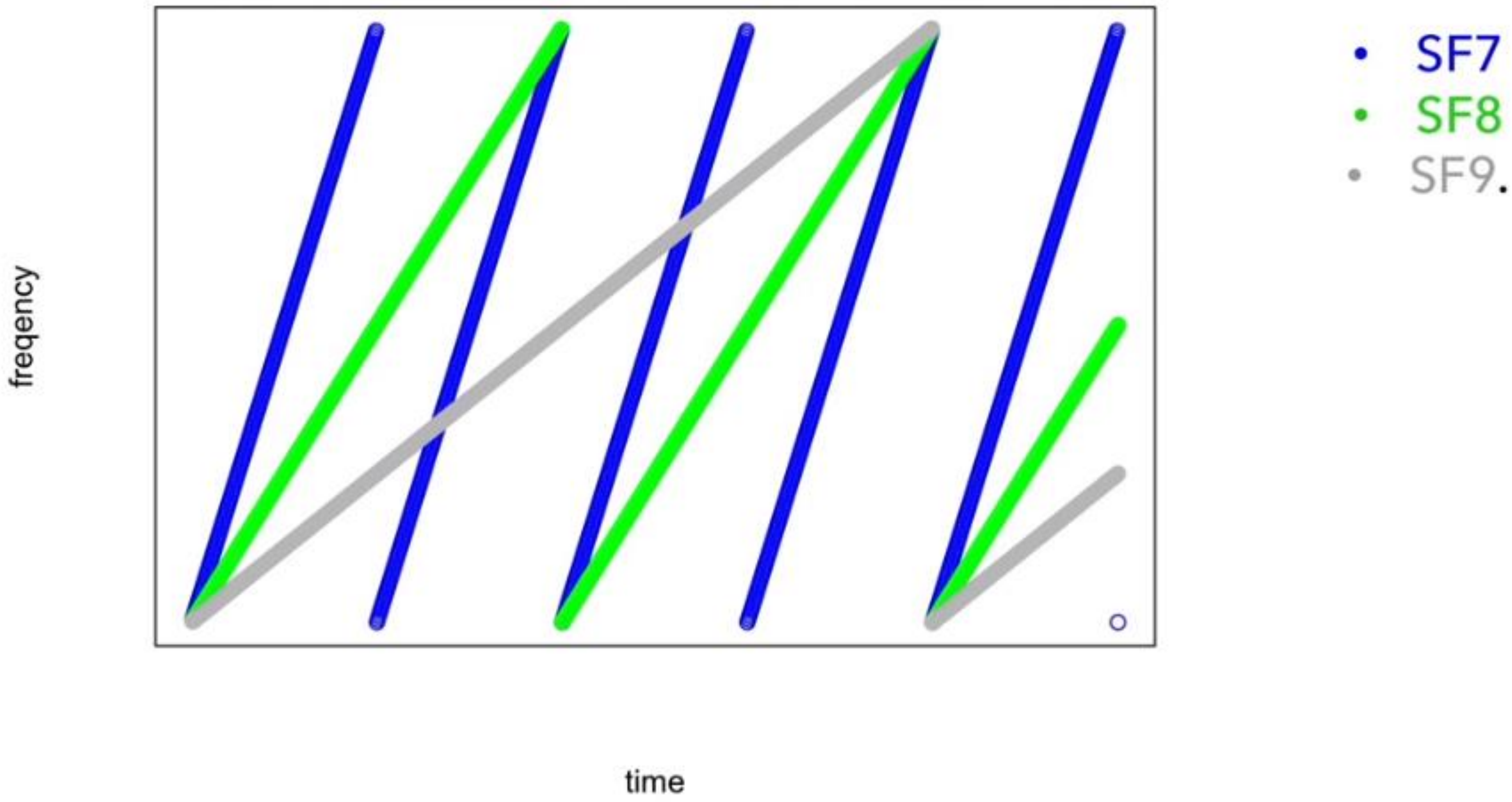
Frequency-shift Keying



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:

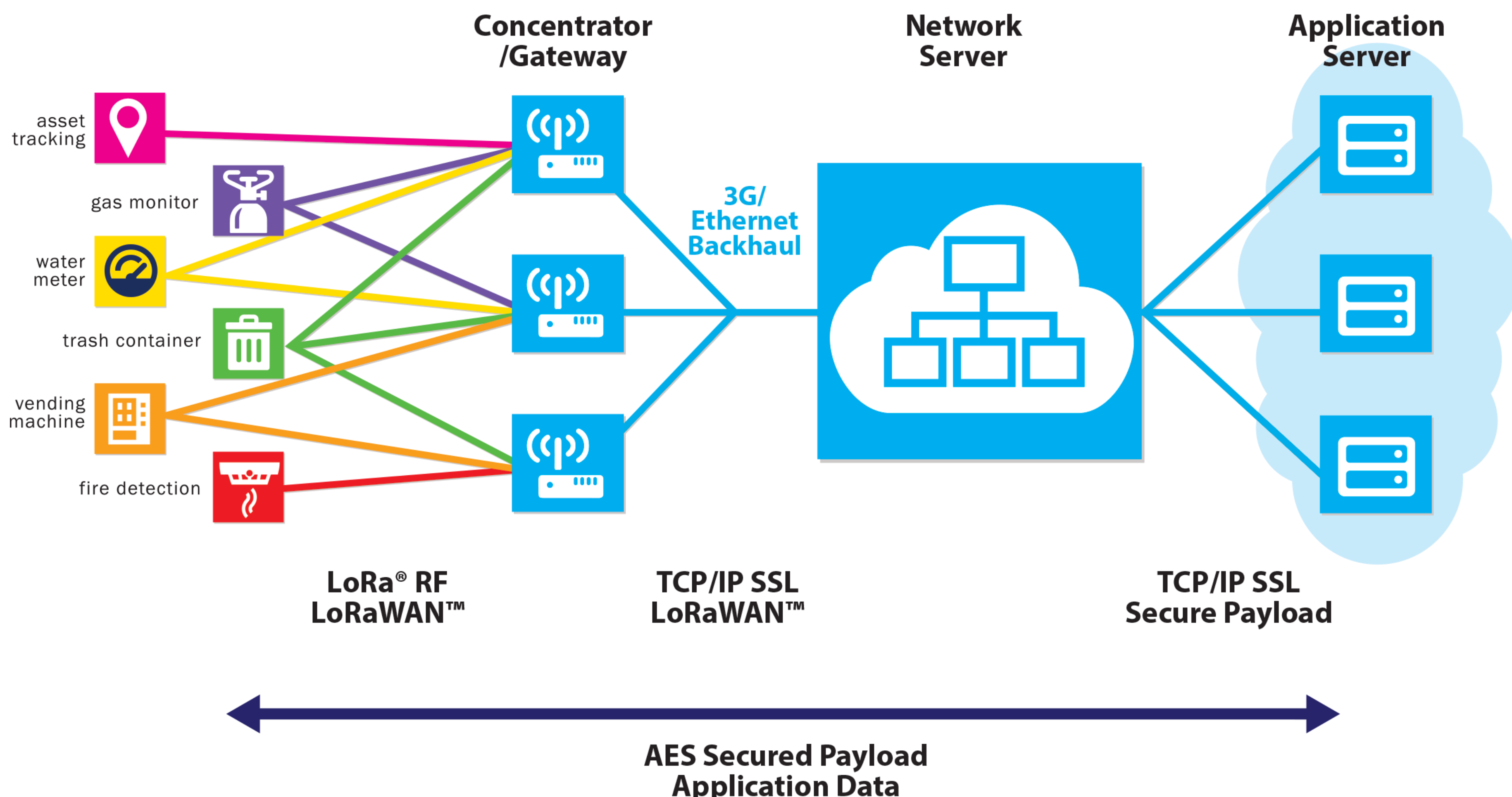
SF = spreading factor (7..12)

BW = modulation bandwidth (Hz)

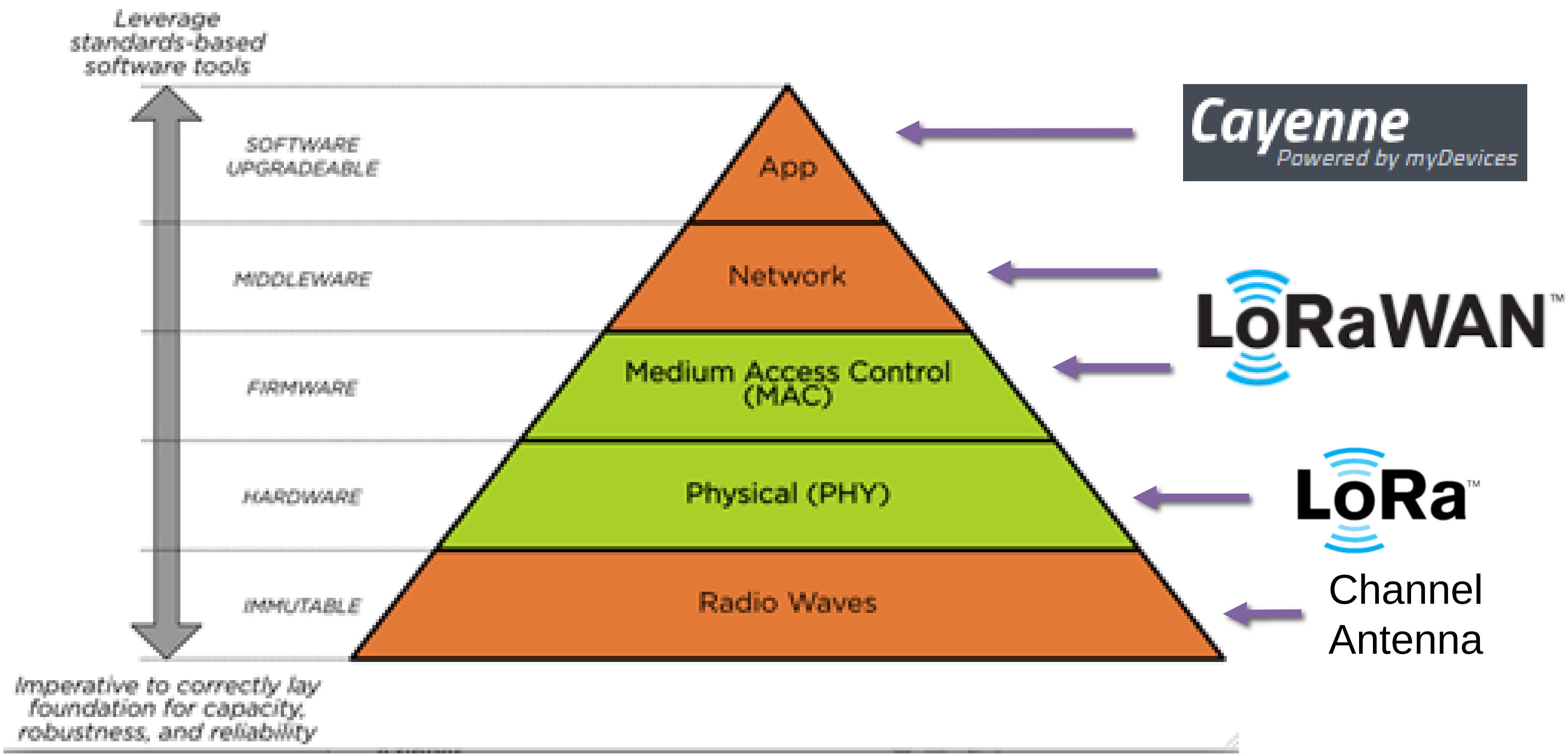
Mode	Equivalent bit rate (kb/s)	Sensitivity (dBm)	Δ (dB)
FSK	1.2	-122	-
LoRa SF = 12	0.293	-137	+15
LoRa SF = 11	0.537	-134.5	+12.5
LoRa SF = 10	0.976	-132	+10
LoRa SF = 9	1757 b/s	-129	+7
LoRa SF = 8	3125 b/s	-126	+4
LoRa SF = 7	5468 b/s	-123	+1
LoRa SF = 6	9375 b/s	-118	-3

Table 1: Link Budget Comparison for Narrowband FSK

LP-WAN network



LoRa vs LoRaWan



LoRaWan Class A

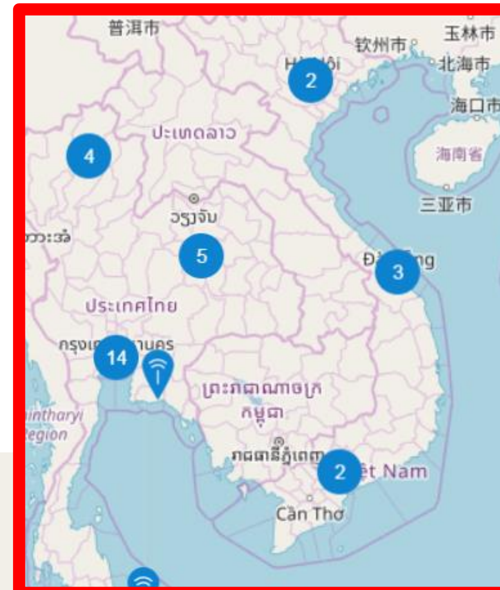
FRMPayload size (Bytes)	240 bps SF12/125k	1 kbps SF10/125k	5.5 kbps SF7/125k
4	~5 uA	~2.2 uA	~1.2 uA
16	~7 uA	~2.5 uA	~1.3 uA
30	~9 uA	~3 uA	~1.4 uA

Assumptions: Pout = +14 dBm, Average Current

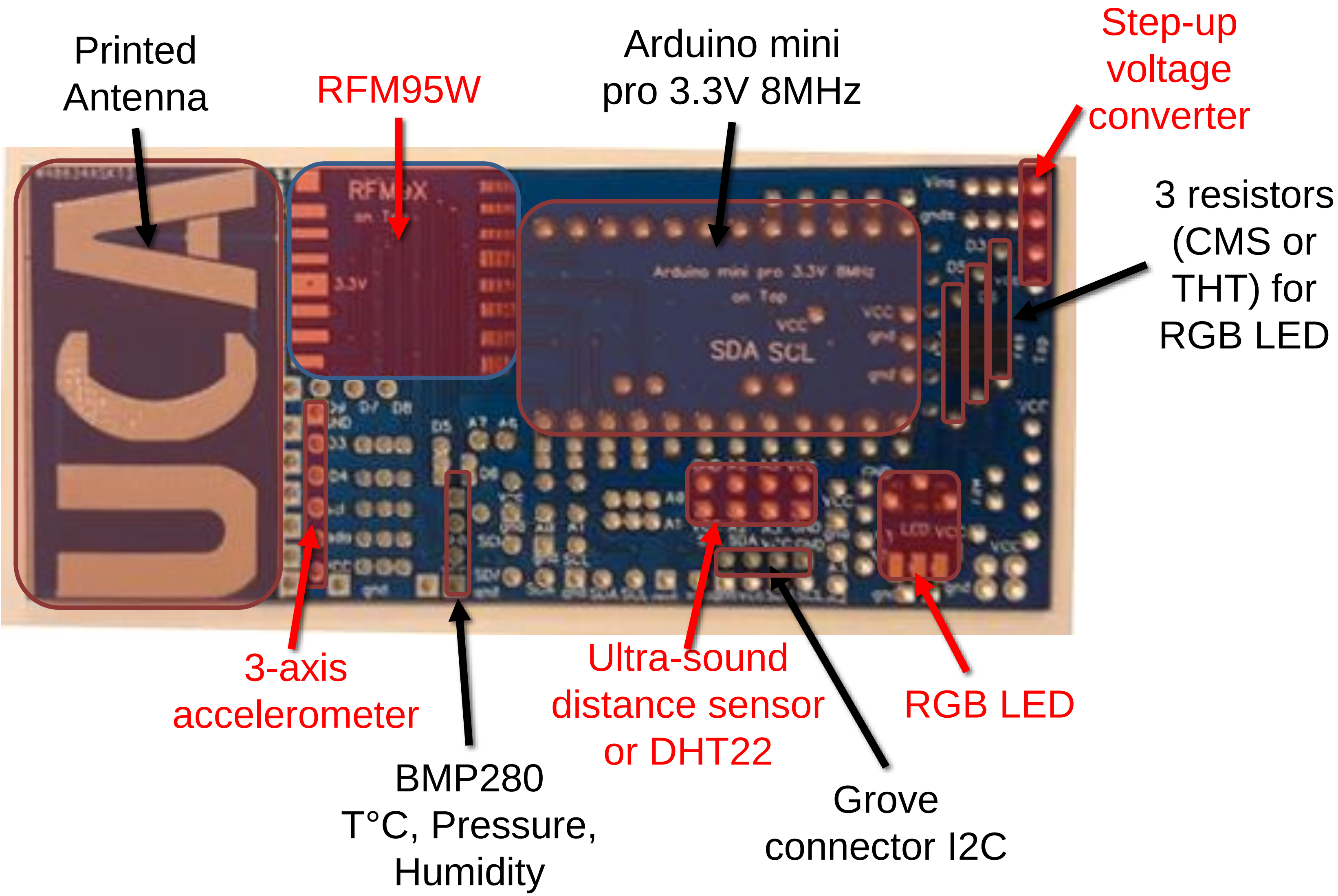
- 10 packets / day
- Sleep current ~1uA (includes the MCU)
- MCU is mostly Off during Tx
- No ACK received
- The energy usage of the 2 unused Rx windows is low (<10%)
- Pout = +14 dBm, IDDTX = 32 mA

The Things Network : LoRa back end ser ver

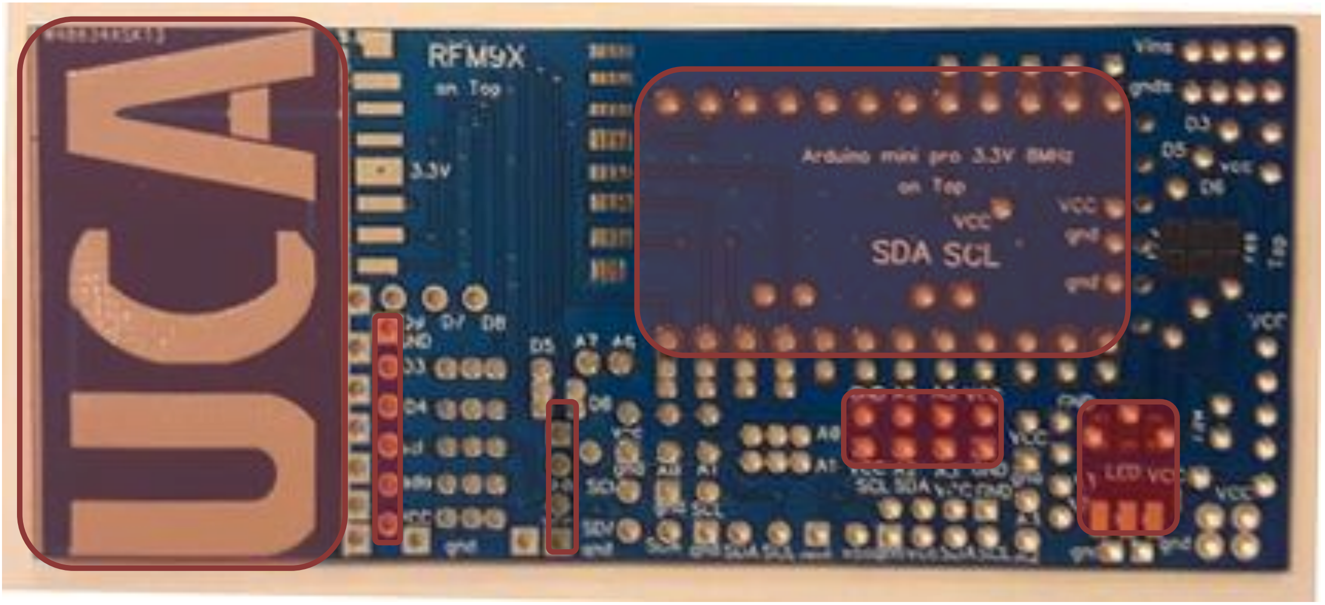
- The Things Network is a global, open, crowd-sourced Internet of Things data network.
- **<u>The Things Network Backend</u>** route messages from Nodes to the right Application, and back
- More than 5000 GWs connected in the world



UCA IoT Plateform



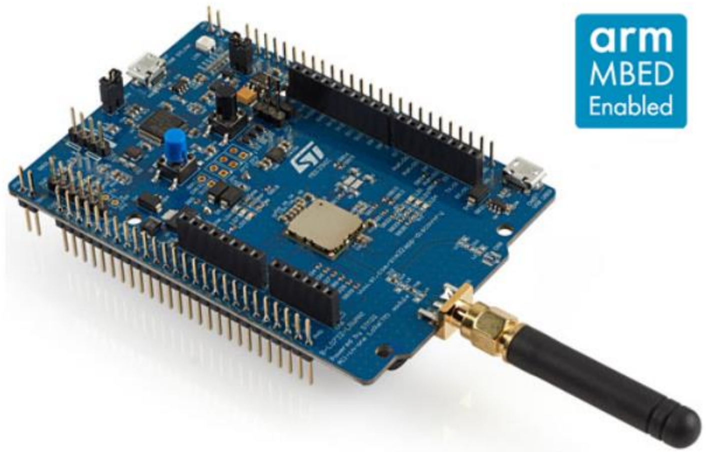
UCA IoT Plateform



- 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/

STM32 Murata Plateform



- Plateform provided by ST Microelectronics
- Murata module
- CMWX1ZZABZ-091 LoRa module (Murata)Embedded ultra-low-power STM32L072CZ Series MCUs, based on Arm® Cortex®-M0+ core, with 192 Kbytes of Flash memory, 20 Kbytes of RAM, 20 Kbytes of EEPROM

http://univ-cotedazur.fr/events/stm32-iot-contest

Outline

- LP-WAN motivation
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- 2018-2019 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
Ass. Prof. F. Ferrero

DUT
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? Has this solution been submitted or awarded in any other competitions/challenges/etc.? ***Note:*** 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 (a) The approach to solve the problem? (b) The construction or design of the solution? (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: (a) in term of technical approaches? (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? (a) Does the solution solve a problem on campus? (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 …

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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 **10th 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 **30th of December 2019**, provide 1-page of your idea. 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 …) and more
- **CIT** : Green technology and e-learning (Energy harvesting, smart teaching …)

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