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LoRa brief presentation

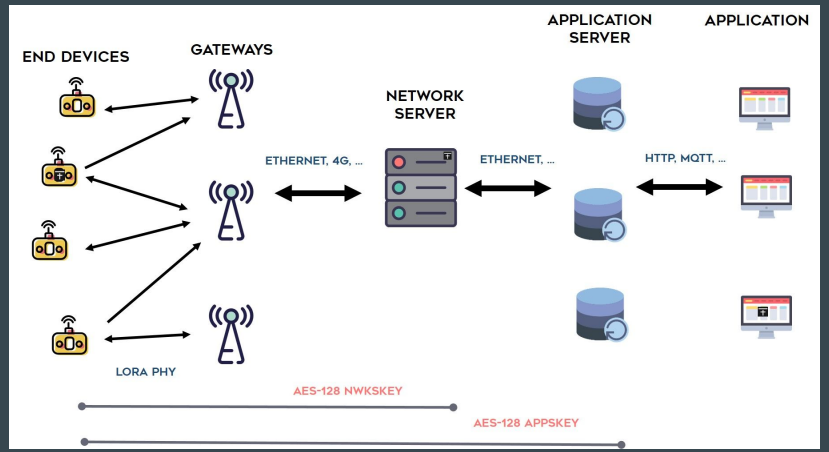
Orange network coverage : 95% people

Bouygues network coverage : 86% of outdoor surface

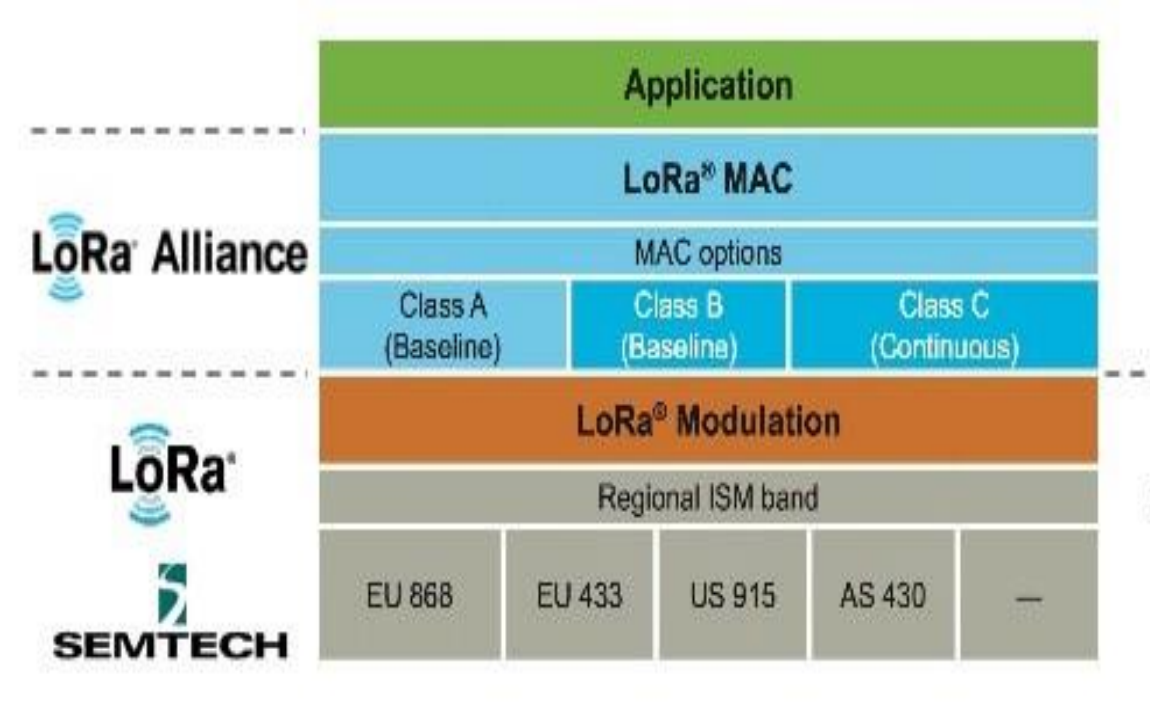
} In France

Frequency for LoRa

	Europe	North America	China
Frequency Band	868 MHz	910 MHz	920 MHz
Power transmission	+14 dBm	+27 dBm	+22 dBm



Lora Layers



Uppers layers

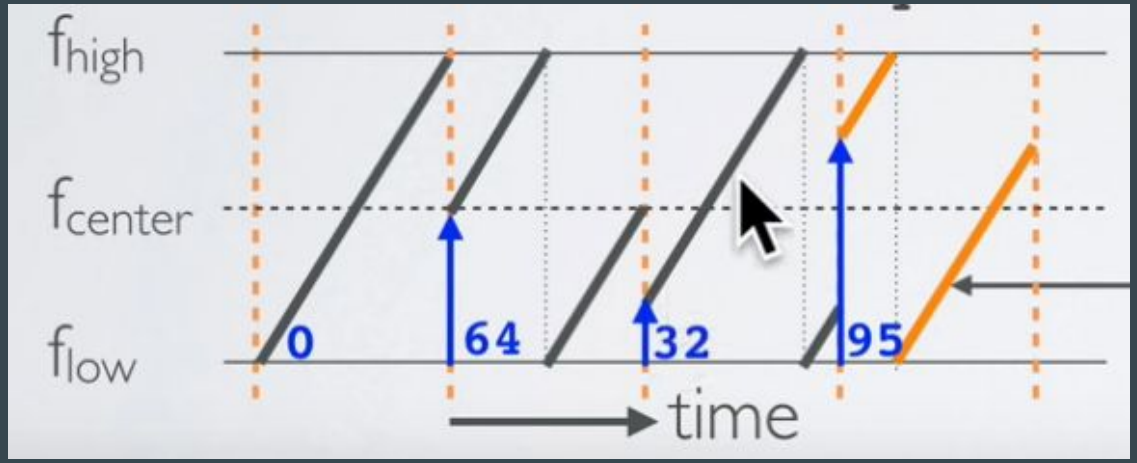
Generally LoraWan

Physical layer

Proprietary protocol
Define the modulation (CSS)

Physical Layer

Chirp **S**pread **S**pectrum



A chirp is a signal which frequency either increase or decrease with time

The information is coded using the **frequency offset** of the chirp

Physical Layer

3 different bandwidths

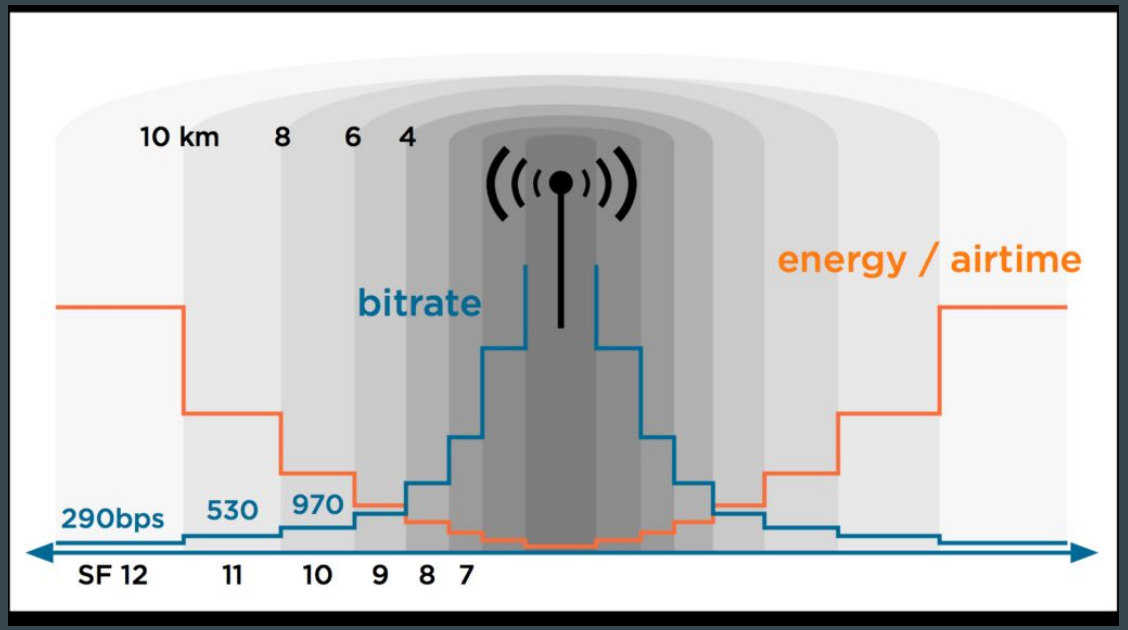
125kHz - 250kHz - 500kHz

6 Spreading Factors

SF7 - SF12

Represents how the signal is spreaded
Number of bits per chirp

Bit Rate = SF * BW / (2^SF)



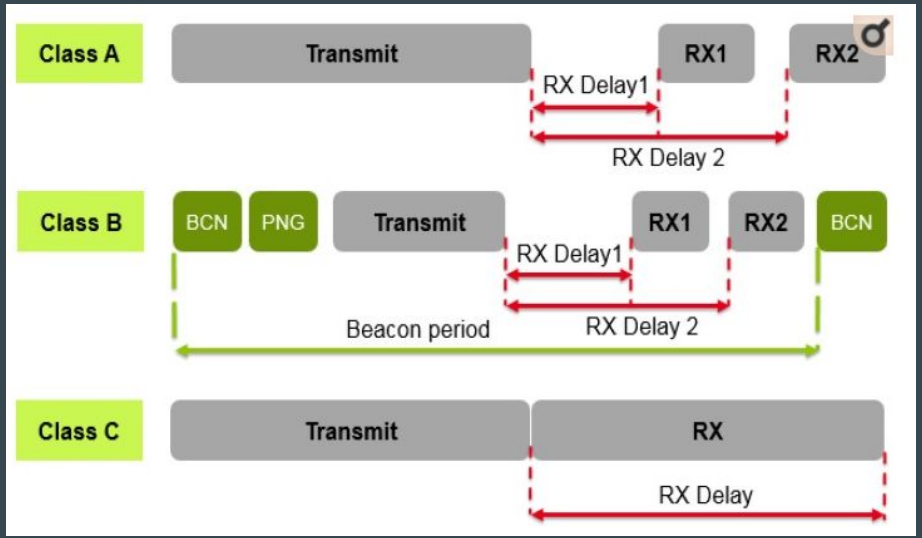
MAC layer

Class A : **Minimal power Application**

Each Device can transmit (Uplink) to the Gateway without checking the availability of the receiver. If the transmission fails, it will be retransmitted after for a while. This transmission is followed by 2 very short reception windows.

Class B : **Scheduled Receive Slot**

Class B Devices have the same behaviour as Class A Devices, but other reception windows are programmed at specific times. In order to synchronize the windows The Gateway must transmit beacons on a regular basis to receive the LoRa device.

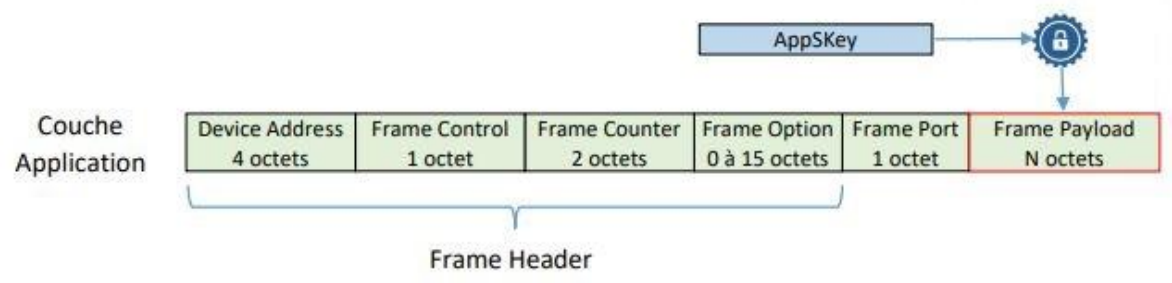


Class C : **Continuously Listening**

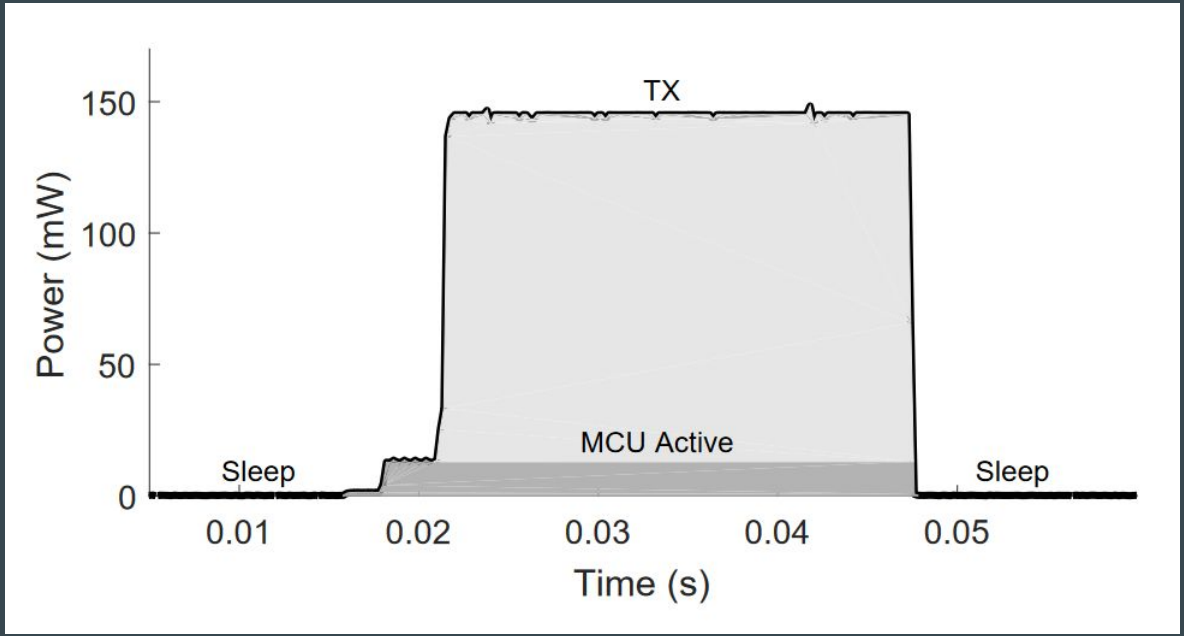
Class C Devices have reception windows constantly open between 2 Uplinks. These
Devices therefore consume much more.

Applicative layer

- **Frame Header** allows you to specify the DevAddr, the Frame Control, the Frame Counter, and the Frame Option.
- **Frame Port** depends on the type of application and will be chosen by the user.
- **Frame Payload** contains the data to be transmitted encrypted with the AppSkey.



Energy consumption



Sleep state

MCU requires energy for time counting

Can be significant across a long period of time

Active state

The MCU requires energy for completing its tasks and mainly for radio transmission

Energy consumption

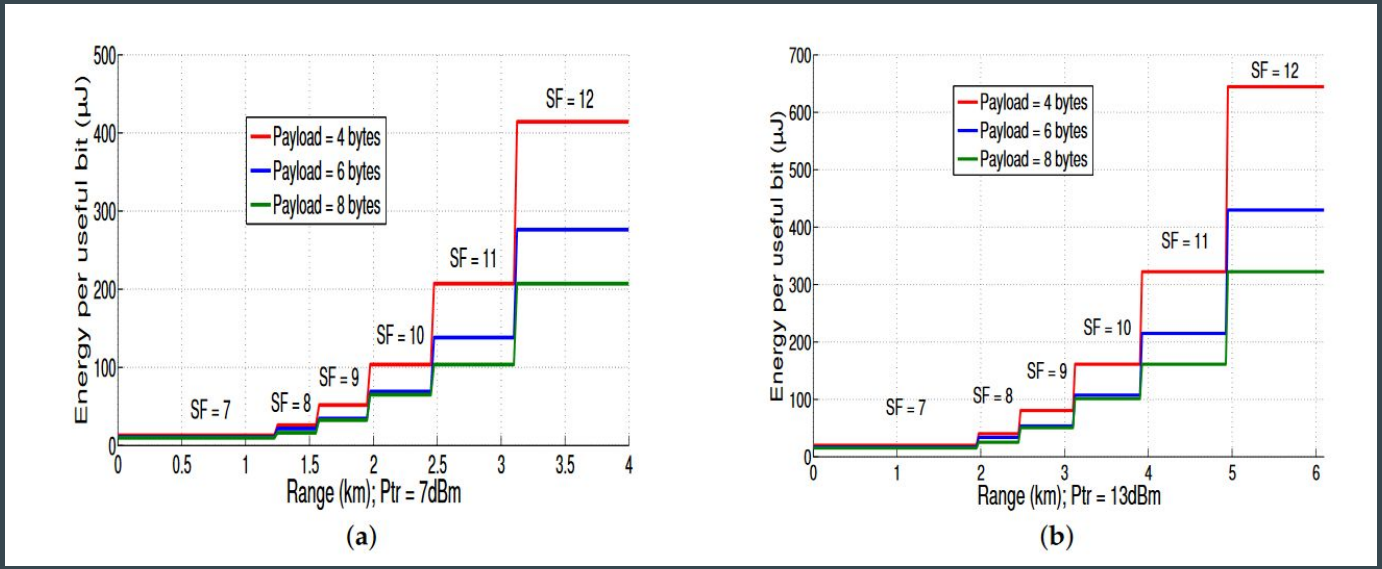
States		Time (ms)	Energy (mJ)	Budget (%)
SF7 2dBm	MCU Active	40.50	0.50	0.30
	MCU Sleep	899959.50	71.28	43.14
	Radio TX	38.85	4.36	2.64
	Radio Sleep	899961.15	89.10	53.92
		Total	165.24	4.60 years
SF12 20dBm	MCU Active	933.00	12.25	2.22
	MCU Sleep	899067.00	71.21	12.87
	Radio TX	926.70	380.73	68.82
	Radio Sleep	899071.30	89.01	16.09
		Total	553.20	1.37 years

High TX power ⇒ High energy consumption

High SF ⇒ Long transmission ⇒High energy consumption

PL = 6 Bytes, CR = 4/8, BW = 125kHz, 15 minutes per packet, battery capacity of 3.7V 2Ah

Energy consumption



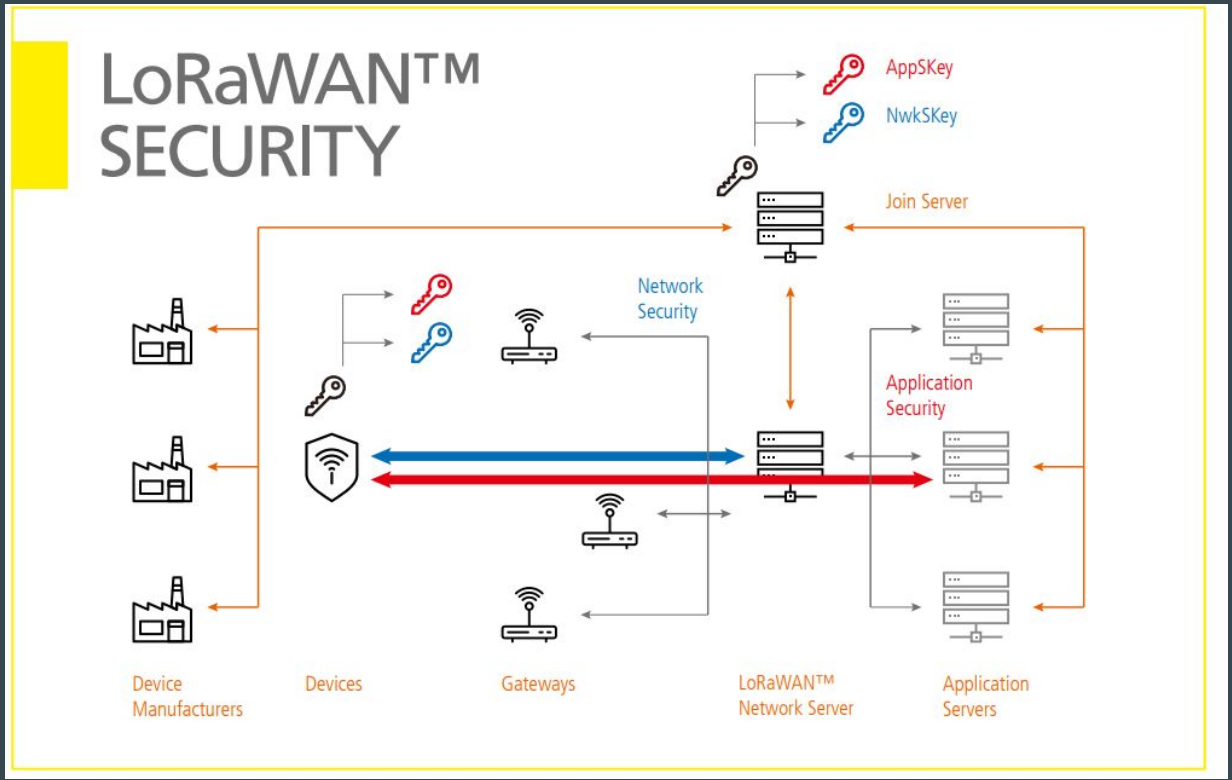
Energy per useful bit for two scenarios

Range = 3km
Payload size = 4 bytes

SF = 11 & Tx = 7dBm
⇒ 200μJ/bit

SF = 9 & Tx = 13dBm
⇒ 100μJ/bit

Security



Each device has a unique 128 bit AES key (called AppKey) from which is generated the **AppSkey** and the **NwkSkey.**

AppSkey : End to End Encryption

NwkSkey : Distributed to the LoRaWAN network in order to prove/verify the packets authenticity and integrity.

AVOIDING A REPLAY ATTACK

The Application Server will accept a only if the "Frame Counter" received is higher than the "Frame Counter" previously received.

LoRa Geolocation

Objenious by Bouygues Telecom

Objenious makes geolocation of objects to within 50 meters without GPS

The Time Differencial of Arrival (TDOA) consists in observing the time of arrival of messages sent to multiple antennas by an object in order to deduce its position.

Thanks for your attention

Source :

[1] https://lora-alliance.org/about-lorawan

[2] https://scem-eset.univ-smb.fr/wp-content/uploads/2017/02/Cours-LORA-LORAWAN.pdf

[3] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6068831/

[4] https://www.ntu.edu.sg/home/limo/papers/TOSN-LoRa.pdf