

# Protocols for WSN : Sigfox

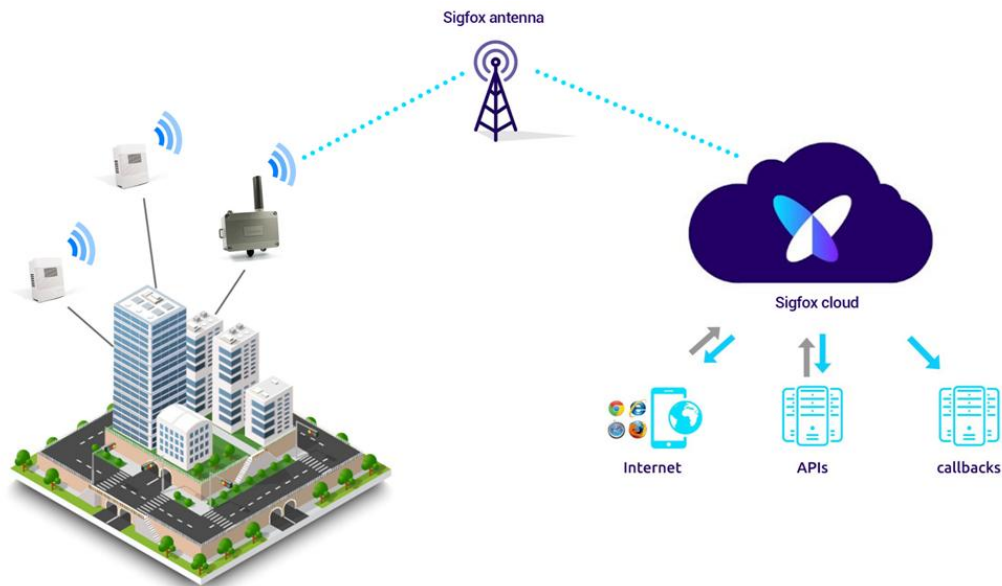
Innovative Smart Systems - INSA Toulouse

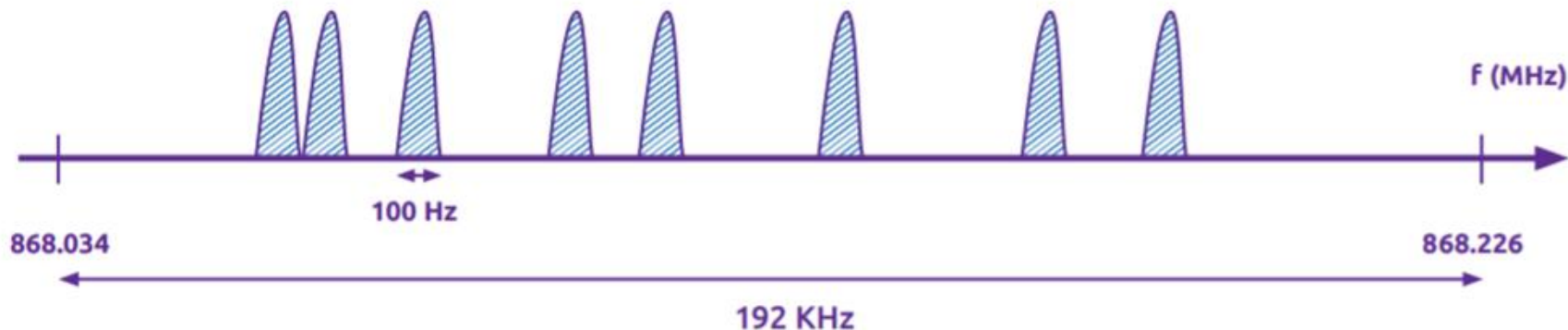


# Contents

- I. Physical layer
- I. MAC layer
- I. Security, authentication and integrity
- I. Energy consumption

- ❖ Founded in 2010 in Toulouse
- ❖ Provides the **network and the technology**
- ❖ Network **dedicated to IoT**





- ❖ Ultra Narrow Band (UNB)
- ❖ Binary Phase Shift Keying
- ❖ ISM (868.034 MHz to 868.226 MHz in Europe)

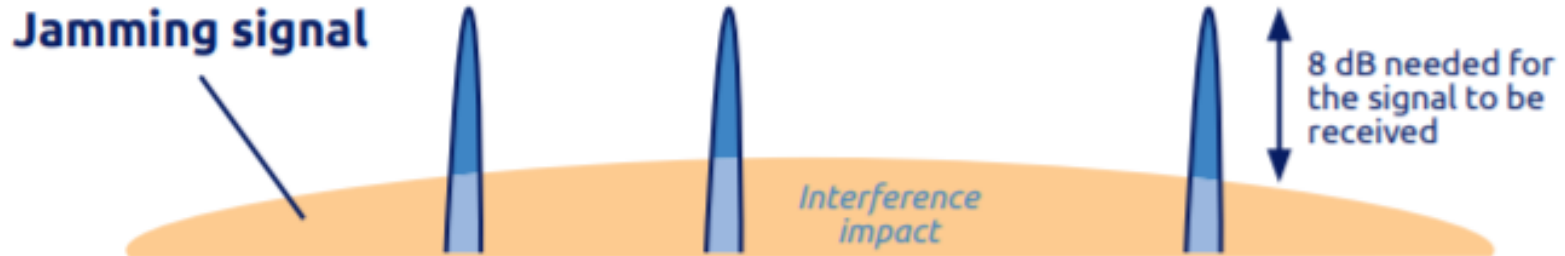
## Disadvantages :

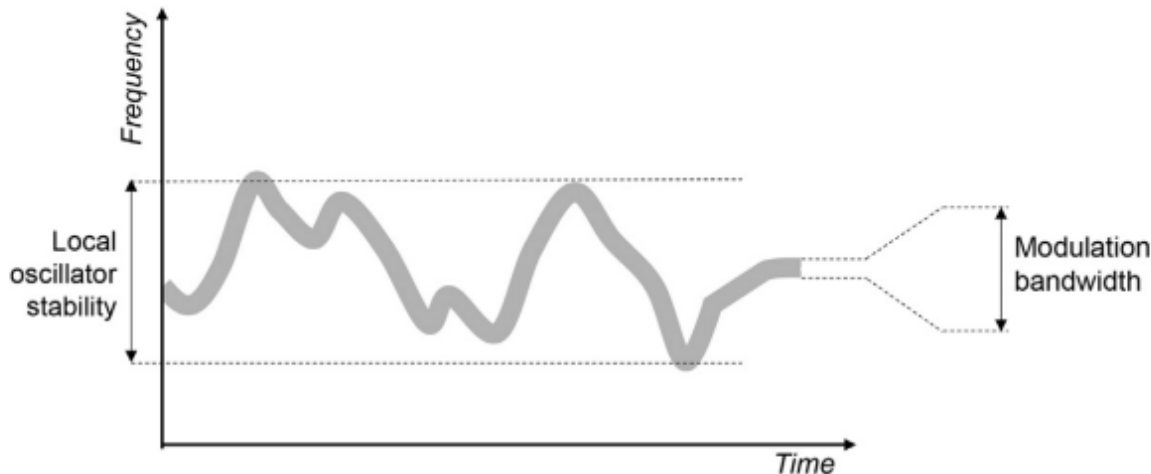
- ❖ BPSK → Low spectral efficiency
- ❖ **Low spectral efficiency** = Low rate phase modulation / Narrow frequency band
- ❖ Data rate : 100 bit/s (in UL communication)
- ❖ ISM : the band can be occupy 1% of the time → 6 12 bytes messages per hour or 140 messages per day

Communication	Symbol rate name	Symbol rate (in baud)	Cumulated error over full length of radio burst
uplink	BR100 <sub>UL</sub>	100	+/- 3%
	BR600 <sub>UL</sub>	600	+/- 3%
downlink	BR600 <sub>DL</sub>	600	+/- 0,01%

## Advantages :

- ❖ Power is concentrated in a narrow frequency band → Distance range increased (50 km), resilient to noise



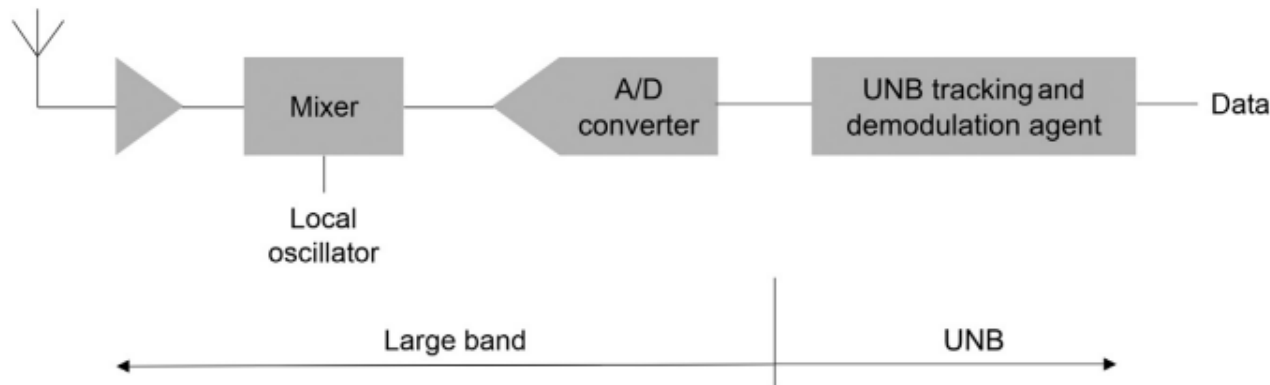


- ❖ Uncertainty of phase modulation oscillators > carrier frequency band

200

Hz > 100 Hz

- ❖ A Software Defined Radio (SDR) is used in reception (but also in transmission)

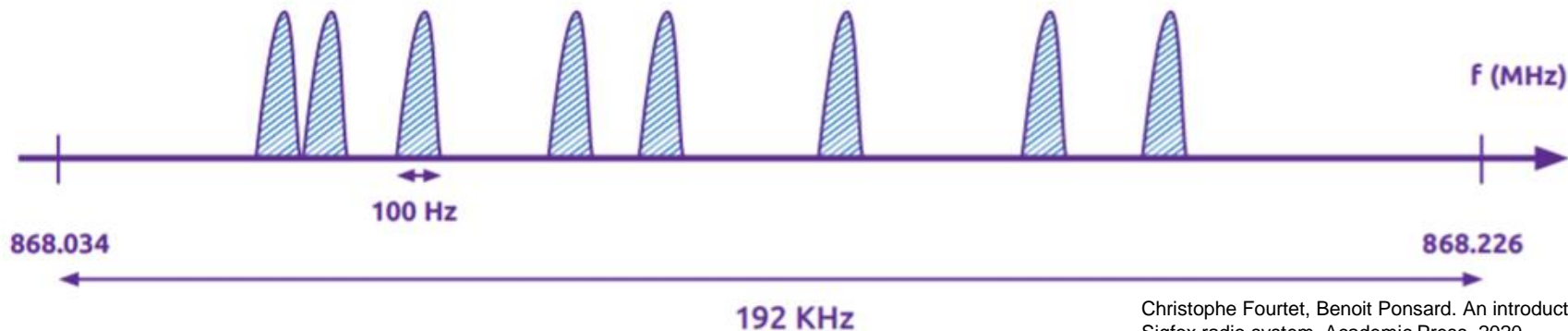


## Software Defined Radio :

- ❖ Cheaper than hardware
- ❖ Receptor : can scan the spectrum and then follow the right frequency
- ❖ Base stations deal with the choice of channel

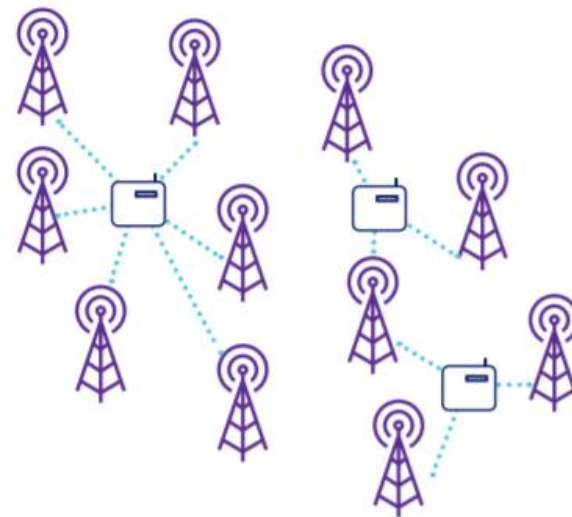
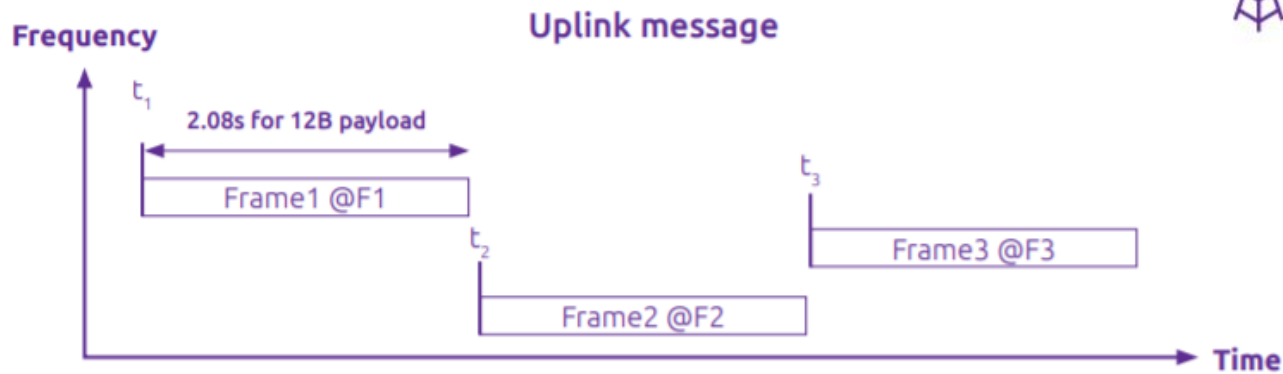


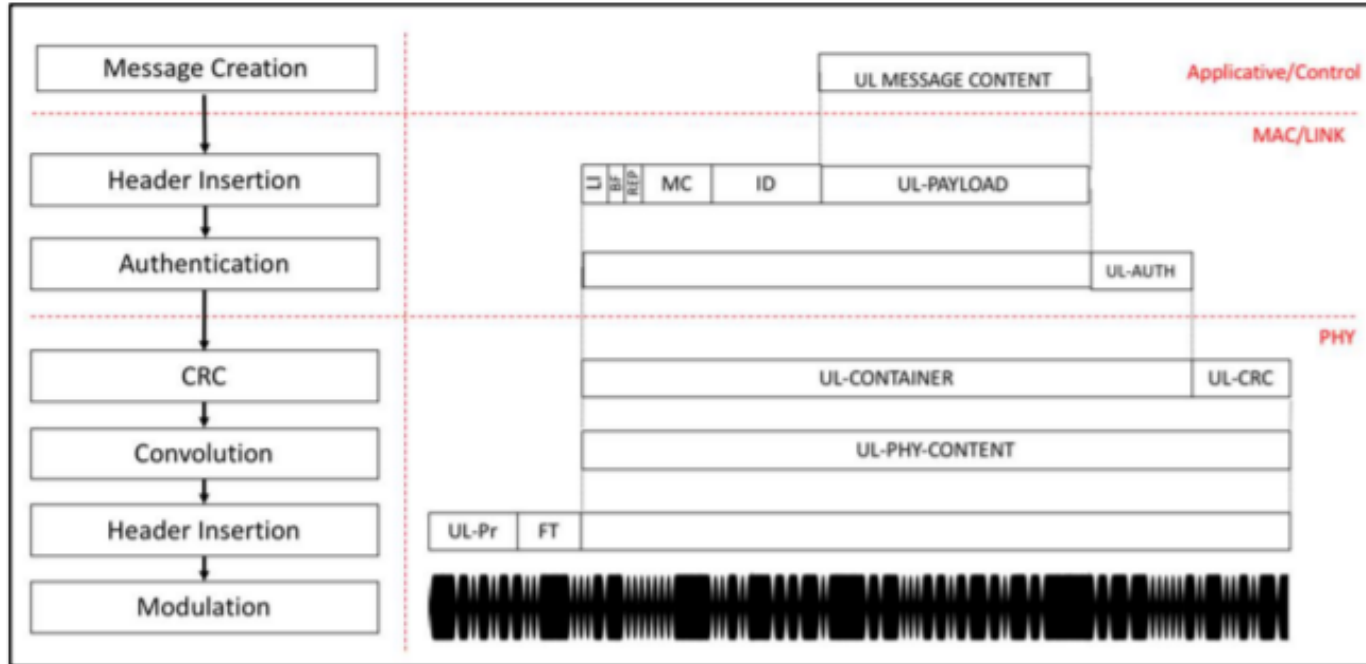
- ❖ Nodes access randomly **in time and frequency** to the wireless medium
- ❖ No contention (**ALOHA**)
- ❖ Cost saving with cheap oscillators



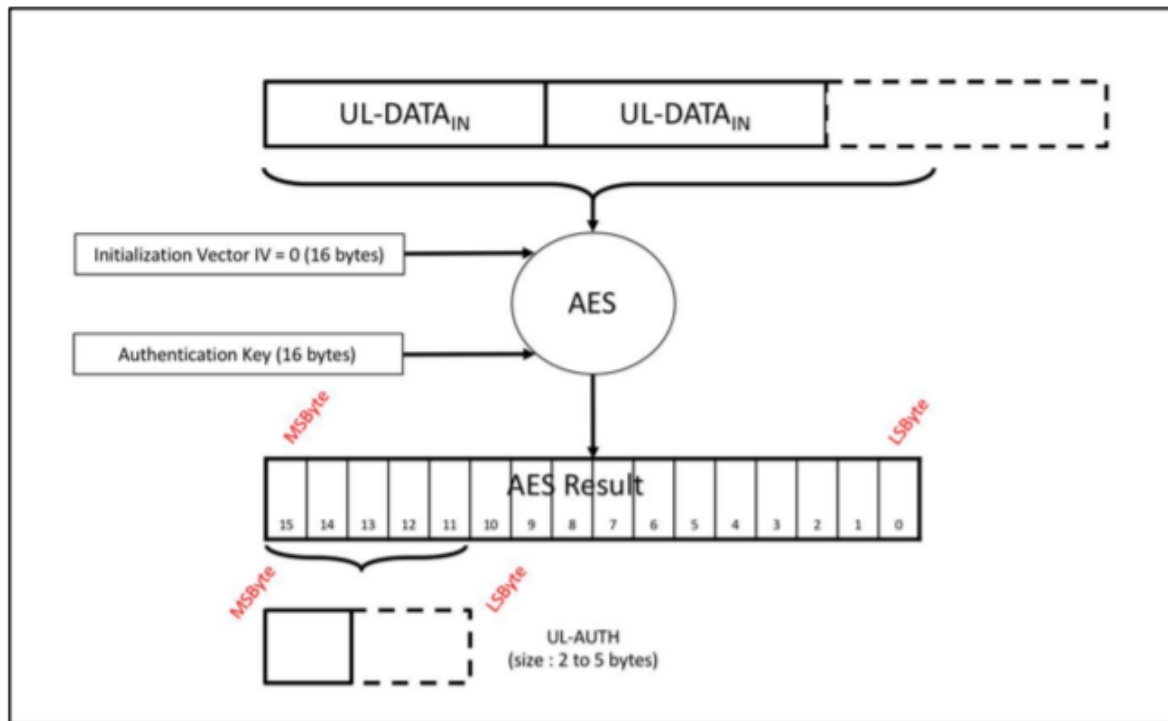
## Triple Diversity :

- ❖ Frequency
- ❖ Time
- ❖ Spatial

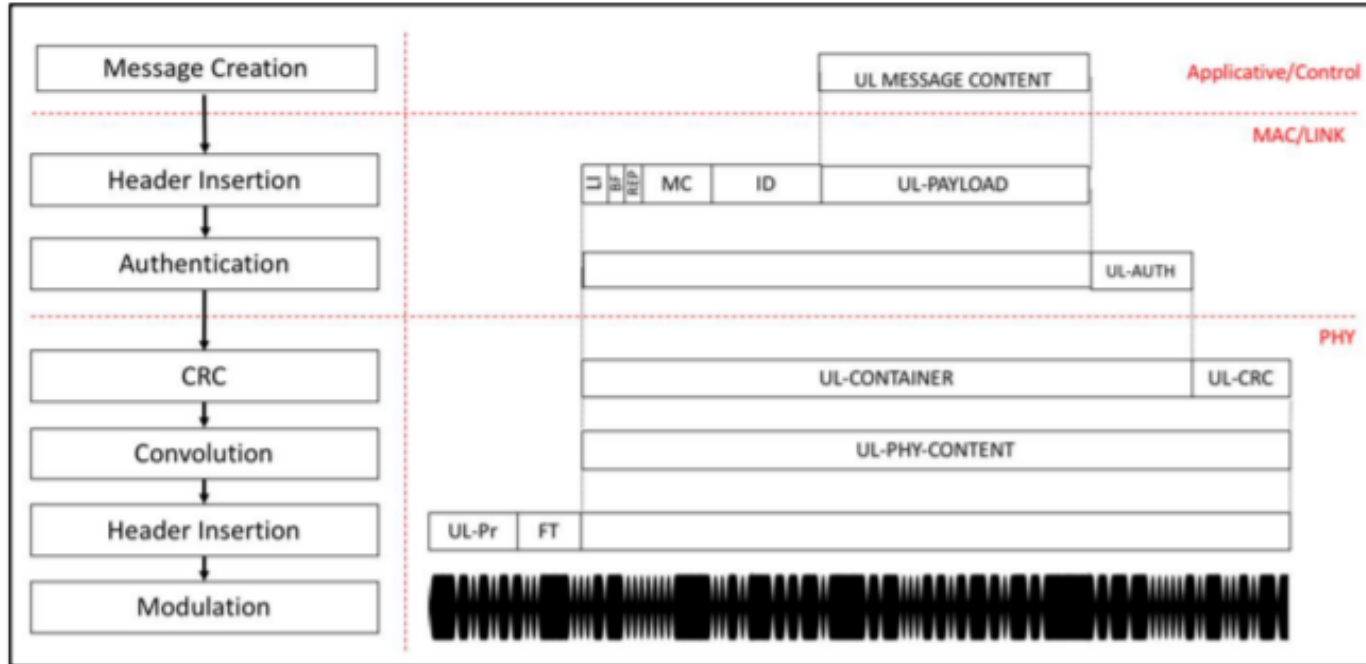




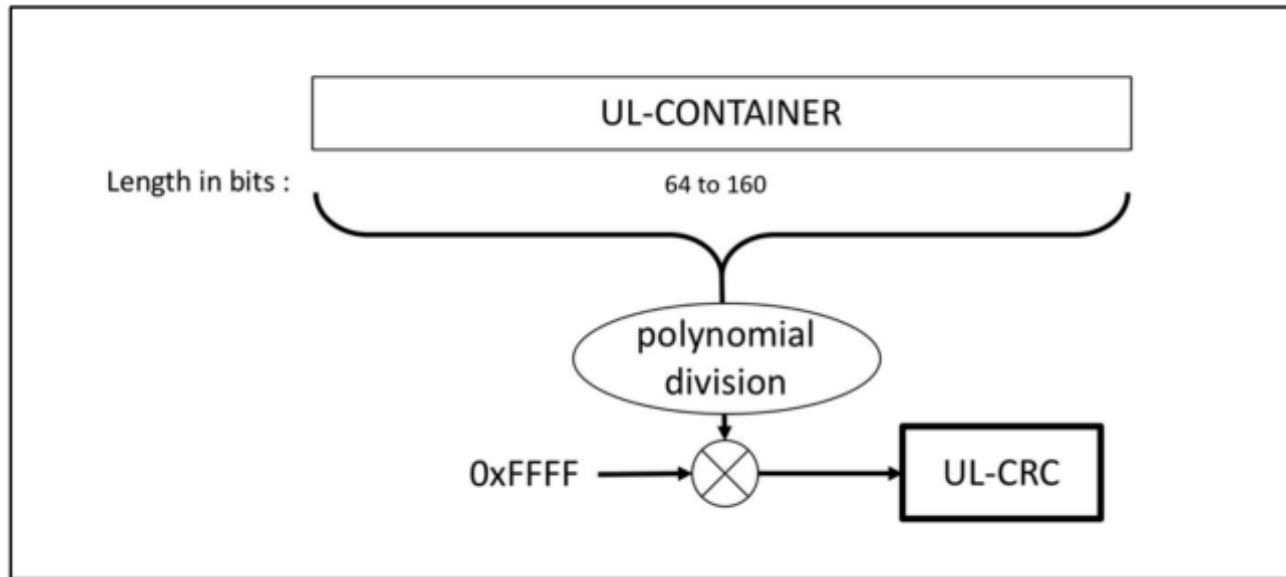
Uplink frame



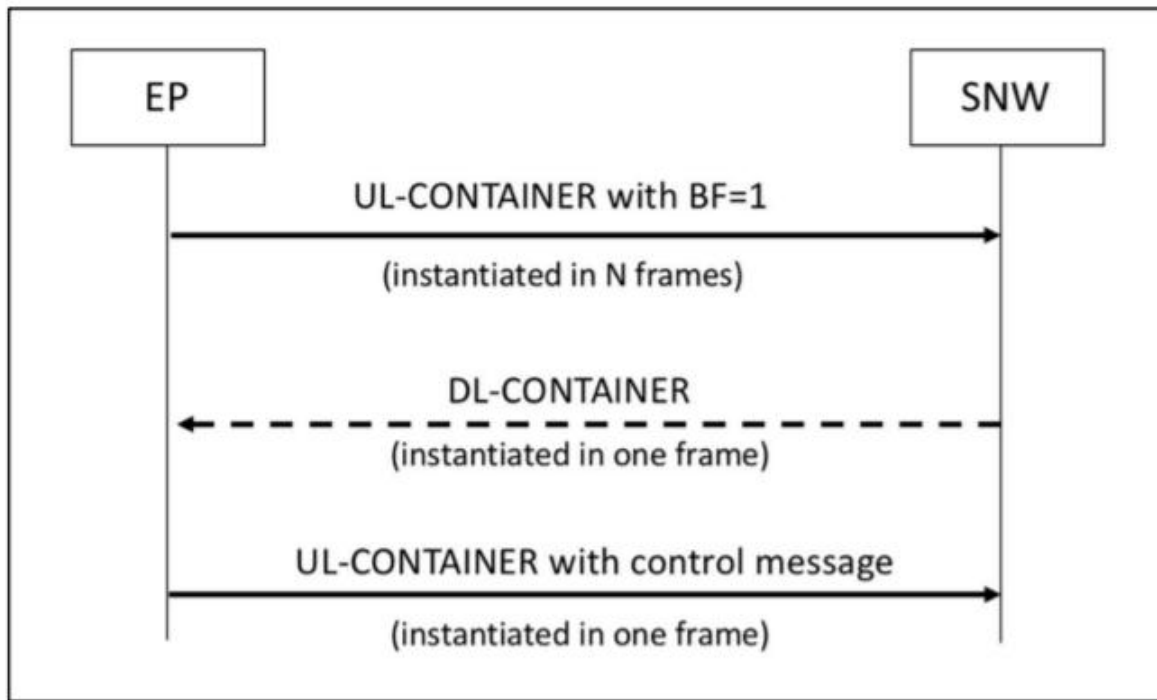
*Principle of UL-AUTH field evaluation*



Uplink frame



*CRC computation in uplink transmission*



*Bidirectional procedure sequence diagram at MAC level. EP : End Point (objects). SNW : Sigfox Network.*

❖ Authentication :

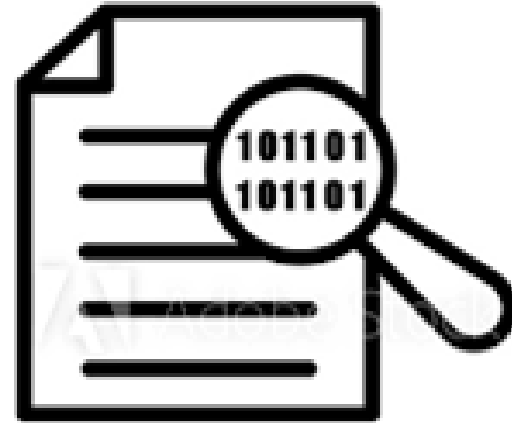
- ID devices link to application
- AES 128 authentication with a private key





❖ Integrity

- 3D diversity
- CRC error detection
- Convolution encoding

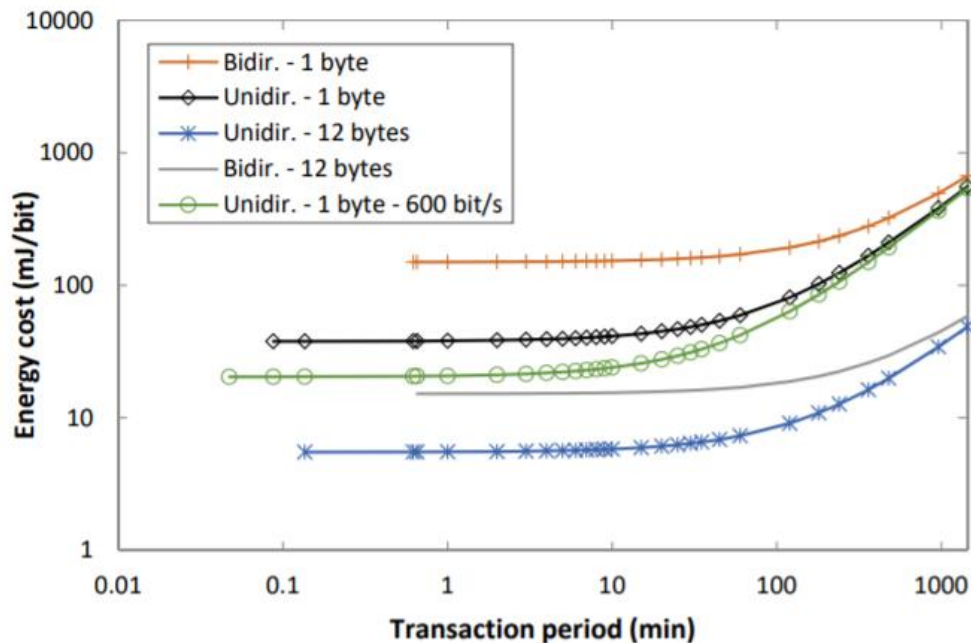


❖ Security

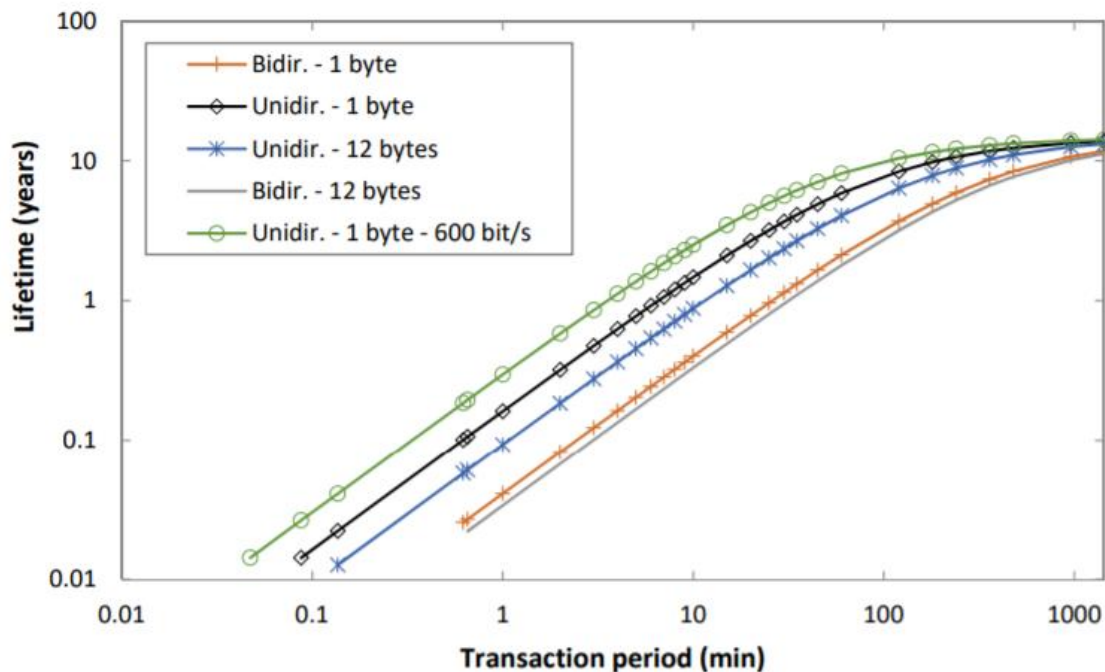
- Message counter against replay attacks
- Data encryption in option



- ❖ 25 mW max UL transmit power and 100 bit/s for data rate → **0.25 mJ/bit**
- ❖ *An introduction to Sigfox radio system*, Christophe Fourtet and Benoit Ponsard (Sigfox), 2020 → **1.8 mJ/bit** (12 bytes in 2 seconds, 25 mW and 100 bit/s)
- ❖ Gomez et al. with in depth study, unidirectional 12 bytes with one message/min → **> 5 mJ/bit** (Arduino MKR FOX 1200)



*Energy cost of data delivery, for unidirectional and bidirectional transactions, as a function of Transaction Period, and for uplink payload sizes of 1 byte and 12 bytes, for FLR (Frame loss rate) = 0.*



*Device lifetime with a 2400 mAh battery, for unidirectional and bidirectional transactions, as a function of TPeriod, and for uplink payload sizes of 1 byte and 12 bytes, for FLR = 0*

- ❖ Sigfox is very simple on the object side
- ❖ Sigfox is suitable for applications that do not require high data rates
- ❖ International coverage and proprietary network
- ❖ Low cost
- ❖ By default Data transmission is in clear