SigFox

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1. SigFox PHY layer

Modulation : Ultra Narrow Band BPSK

Bandwidth : 100 Hz

Bitrate : ~ 100 bps (per device)

Frequency band : 868 Mhz (Europe)

Flat fading:

Frequency uncertainty: shift between desired and emitted frequencies

Problems when using UNB

⚠ flat fading

- Sigfox uses frequency hopping

⚠ the frequency uncertainty is higher that the signal bandwidth (100 Hz)

⇒ overlapping frequency channels

⇒ loss of bandwidth by using guard intervals

- Sigfox MAC protocol has been designed to address this issue

2. SigFox MAC layer

MAC technique for uplink: Random Frequency & TDMA

+ **Energy consumption** (no need to sense the medium before emitting data)
+ **Oscillator precision** : no need for expensive accurate oscillators
+ **No synchronisation** between the nodes (random access)

Random time and frequency slots can lead to interferences if they are too many nodes in the network !

each uplink message is transmitted up to 3 times on different frequencies

Uplink (here) :
device ⇒ gateway

RFTDMA (here) :
random time intervals and in a random frequency within the 192 kHz band

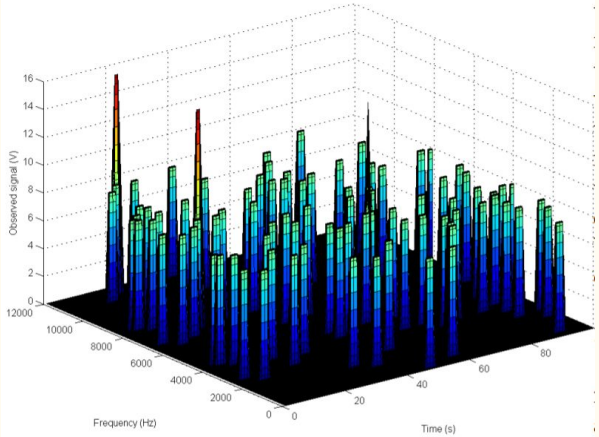
MAC technique for downlink: GFSK modulation

+ **500 bps** inside a 600 Hz wide spectrum segment
+ used for **acknowledgements** and **data transmission**
- **limited to 4 messages a day** (only at specific times)

Downlink only at specific times because the emitting device only listens for messages a few seconds (25 s max) after emitting

3. SigFox network characteristics

- 4 offers from 1-2 to 101-140 messages per day
- Energy consumption: 20 to 70 mA while active (almost 0 while idle)
- Security:
  - an hash code to authenticate the packet
  - ⚠ payload not encrypted !
- Geolocation precision: precision a few kilometers
  - Usable to detect if an object is in a city
  - ⚠ Needs a GPS module to locate precisely
- Range: ~20-40 kms in open air and ~2-5 kms in urban environment



Example of temporal & spectral repartitions of nodes (cf. previous slide)

4. Comparison with LoRa

Criteria	**SigFox**	**LoRa**
Conceptor	SigFox	Semtech
Launch	2009	2012
Proprietary technology	Yes	No
Frequency	868 MHz (EU) 902 MHz (US)	868 MHz
Bandwidth	100 kHz	125 kHz
Frequency of emission	0 - 140 per day	
Bitrate	300 bit/s	0.3 kbps to 50 kbps
Payload size	max 12 bytes	max 256 bytes
Modulation	BPSK	FSK or LoRa (switchable)
Bidirectional	Yes but very limited	Yes (under conditions)