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IoT Challenge #3, Exercises LoRaWAN

Internet of Things

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1.1. Data

In this chapter we answer to question EQ1, asking to find the biggest LoRa SF for having a success rate of at least 70% in a LoRaWAN Network with the following parameters:

- Carrier frequency: $CF = 868MHz$
- Bandwidth: $BW = 125kHz$
- Number of gateways: $N_G = 1$
- Number of sensor nodes: $N_S = 50$
- Intensity of Poisson process: $\lambda = 1$ packet/minute
- Success rate: $SR \geq 0.7$

We compute the payload size based on the last two digits of the leader's person code (XY), according to the formula:

$$L = 3 + XY \text{ Bytes} \tag{1.1}$$

Our leader's person code is 10773593, so the payload size is:

$$L = 3 + 93 = 96 \text{ Bytes} \tag{1.2}$$

1.2. Maximum Spreading Factor calculation

Since LoRaWAN uses an ALOHA-like procedure to handle channel access and retransmissions, we compute the success rate, SR, as the ALOHA success rate:

$$SR = S/G = e^{-2G} = e^{-2N\lambda t} \tag{1.3}$$

Thanks to this formula, we can compute the maximum airtime to have a success rate greater than 70%.

$$SR \geq 0.7 \tag{1.4}$$

$$e^{-2N\lambda t} \geq 0.7 \tag{1.5}$$

By applying the natural logarithm, we get:

$$-2N\lambda t \geq ln(0.7) \tag{1.6}$$

$$t \leq \frac{-ln(0.7)}{2N\lambda} = \frac{-ln(0.7)}{2 \cdot 50 \cdot \frac{1}{60 \cdot 10^3 \text{ ms}}} = 214.005 \text{ ms} \tag{1.7}$$

We now use the API `https://www.thethingsnetwork.org/airtime-calculator` to find the highest SF that guarantees an airtime smaller than the value we found. We use payload size of 96 Bytes, as computed before, region EU868 and bandwidth 125 kHz. The API says that the maximum payload size for EU868 with SF from 10 to 12 is 51 Bytes; this means that we can evaluate SF values starting from 9 and lowering the SF until we find an airtime smaller than 214.005 ms. The values of airtime corresponding to the SF are report in the following table.

Spreading Factor	Airtime
SF9	594.9 ms
SF8	328.2 ms
SF7	184.6 ms

Table 1.1: Airtime based on SF

The only value of SF that leads to an airtime smaller than 214.005 ms and a success rate greater than 70% is SF7.

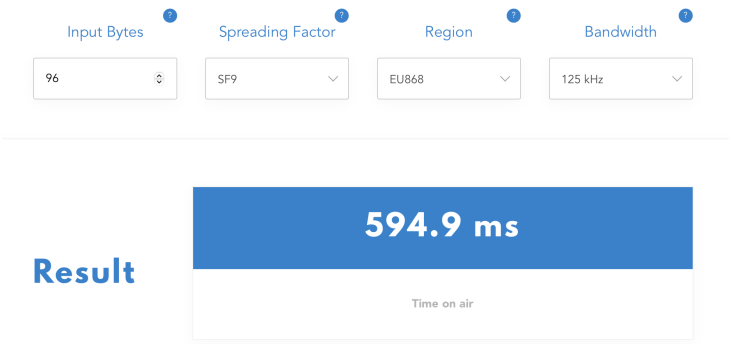

Figure 1.1: Airtime with SF9

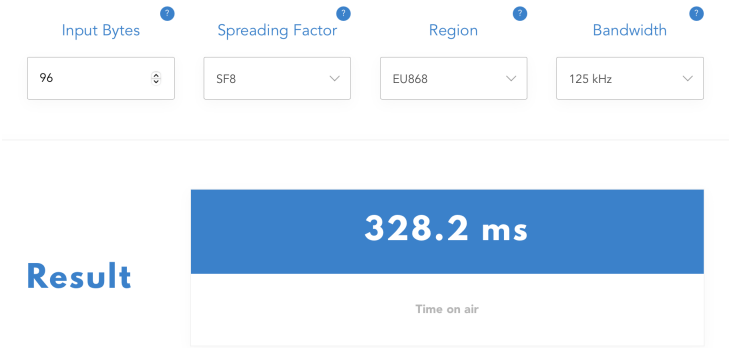

Figure 1.2: Airtime with SF8

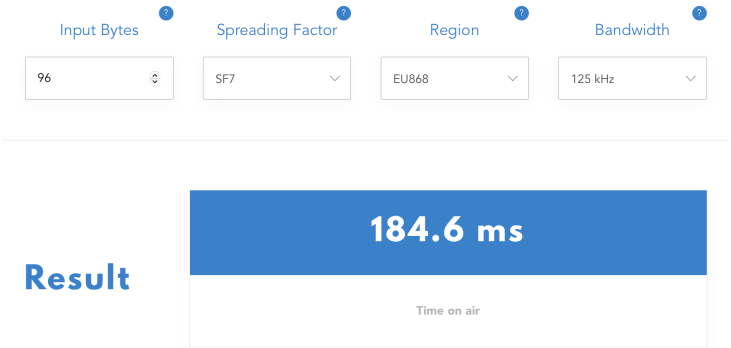

Figure 1.3: Airtime with SF7

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