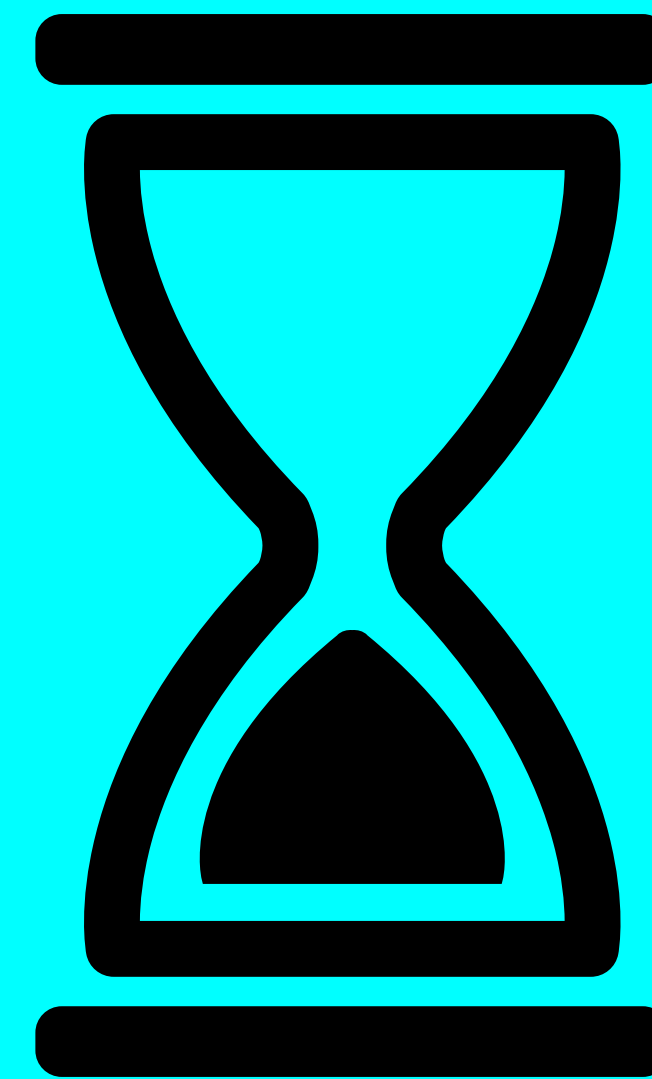


LORA / LORAWAN TUTORIAL 23

ETSI Duty Cycles, TTN Fair Access Policy & Transmit Time Interval



INTRO

- In tutorial 22 I transmitted the message "Hello, world!" every 60 seconds using the sketch `ttn-otaa-mydemo`.
- At the end of that video I asked the question:
Do I comply with the ETSI duty cycles and The Things Network Fair Access Policy if I keep running the sketch for a day?
- In this tutorial I will answer that question and I also will explain what the transmission time interval is and how it is calculated.

ATTENTION

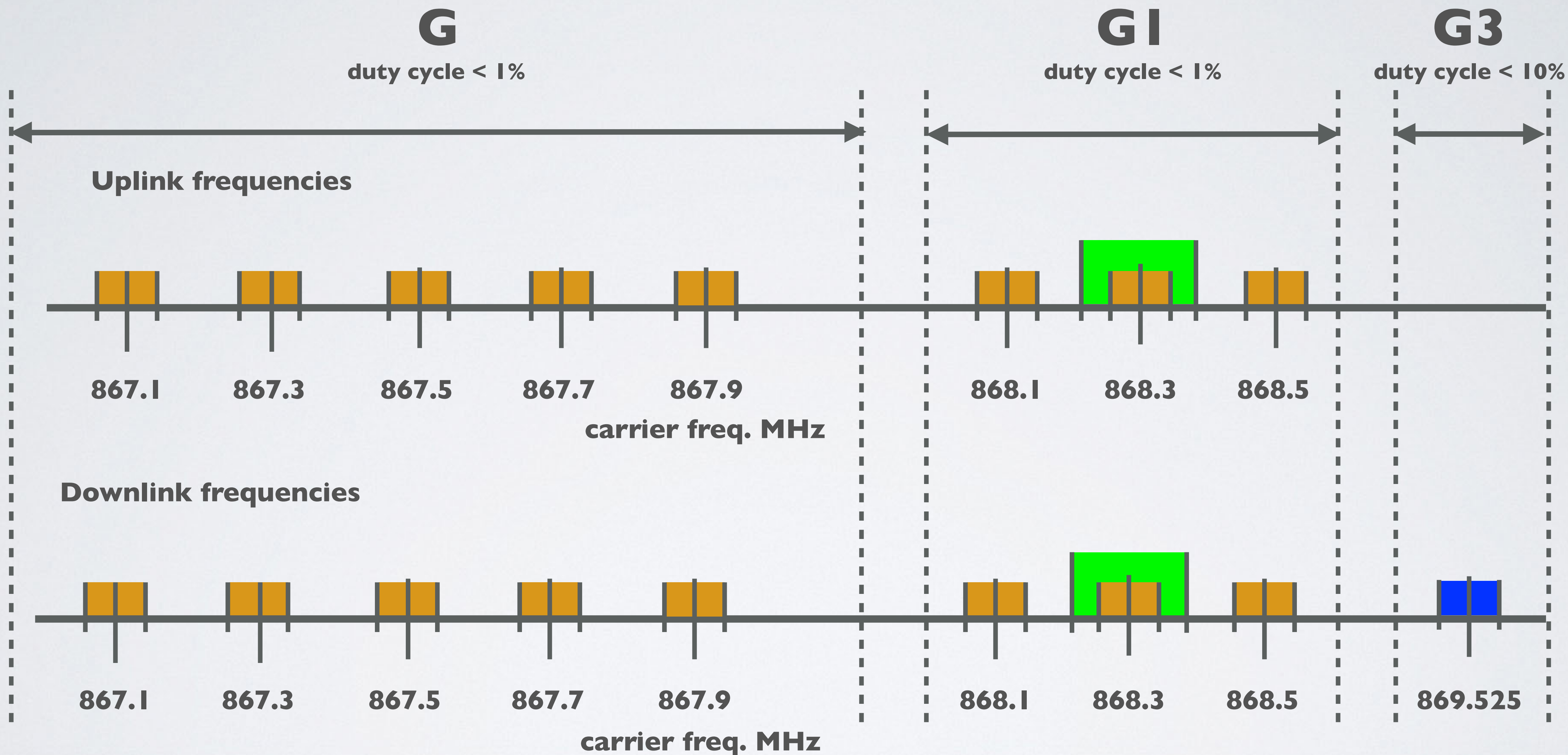
- In this tutorial I will only focus on the ETSI duty cycles and in particular the duty cycles which applies in Europe.
- Please do your own research and check which duty cycles regulations, if any, applies to your country.

ETSI DUTY CYCLE

- In Tutorial 11, I have explained that ETSI divides the 863-870 MHz band into 5 sub-bands: G, G1, G2, G3 and G4 and each sub band has different constraints in terms of ERP, duty cycle and channel bandwidth.

Name	Band (MHz)	Limitations
G	863.0 – 868.0	ERP<25 mW – duty cycle < 1%
G1	868.0 – 868.6	ERP<25 mW – duty cycle < 1%
G2	868.7 – 869.2	ERP<25 mW – duty cycle < 0.1%
G3	869.4 – 869.65	ERP<500 mW – duty cycle < 10%
G4	869.7 – 870.0	ERP<25 mW – duty cycle < 1%

EU863-870 FREQ, SUB BANDS AND DUTY CYCLES

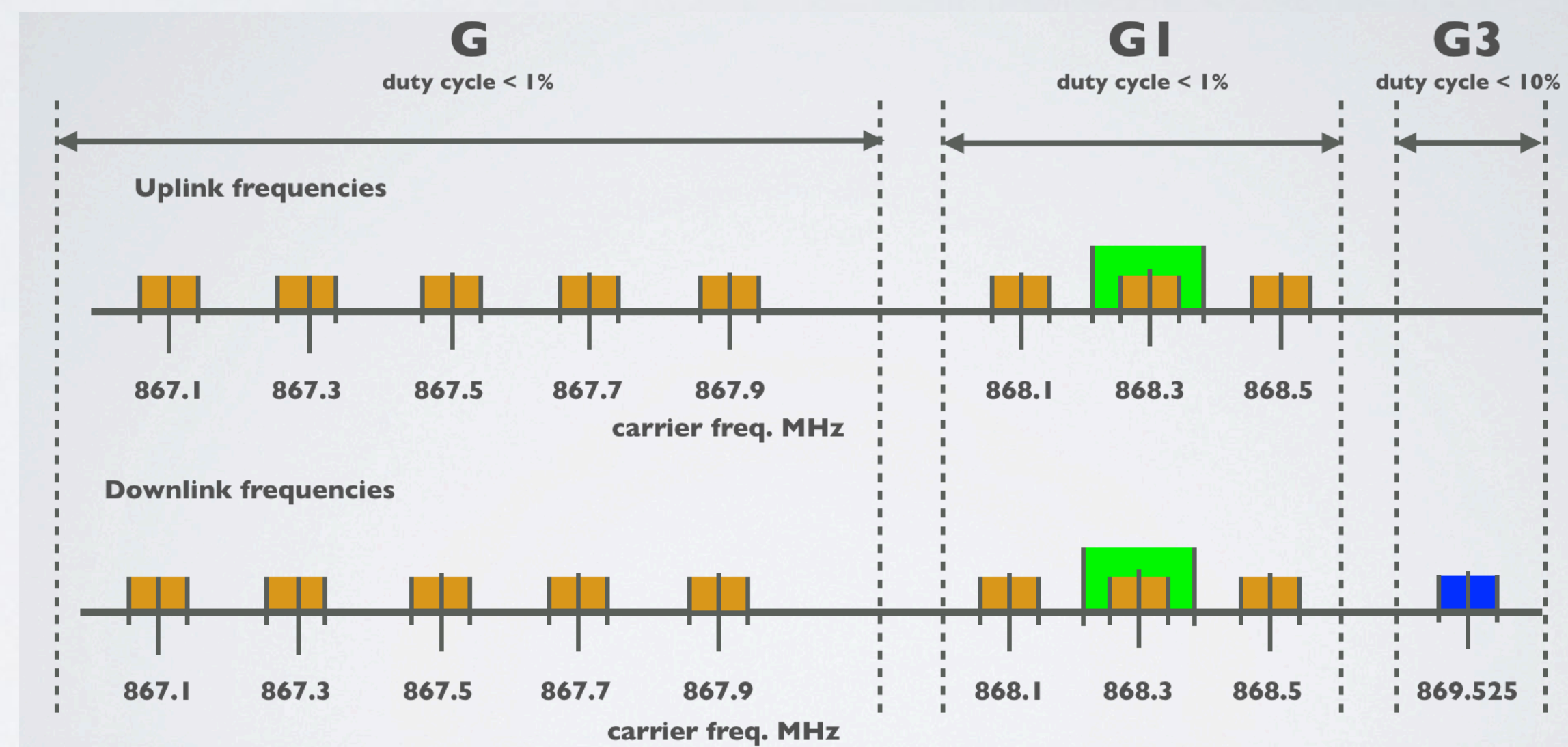


DEMONSTRATION METADATA

- In Tutorial 22 I have demonstrated how to transmit the message “Hello, world!” every 60 seconds.
- The metadata displayed in TTN console during the demonstration can be found here: <https://www.mobilefish.com/download/lora/ttn-otaa-mydemo-data.txt>

DEMONSTRATION METADATA

Counter	Freq (MHz)	Data Rate	CR	Time on Air (ms)
0	867.1	SF8BW125	4/5	82.432
1	868.1	SF8BW125	4/5	82.432
2	868.3	SF8BW125	4/5	82.432
3	867.3	SF8BW125	4/5	82.432
4	868.5	SF8BW125	4/5	82.432
5	868.1	SF8BW125	4/5	82.432
6	867.5	SF8BW125	4/5	82.432
7	868.3	SF8BW125	4/5	82.432
8	868.5	SF8BW125	4/5	82.432
9	867.7	SF8BW125	4/5	82.432
10	868.1	SF8BW125	4/5	82.432
11	868.3	SF8BW125	4/5	82.432
12	867.9	SF8BW125	4/5	82.432
13	868.5	SF8BW125	4/5	82.432
14	868.1	SF8BW125	4/5	82.432
15	867.1	SF8BW125	4/5	82.432



As mentioned in tutorial 11, an end device changes channel in a pseudo-random fashion for every transmission. In Europe for uplink transmissions 8 different frequencies are used.

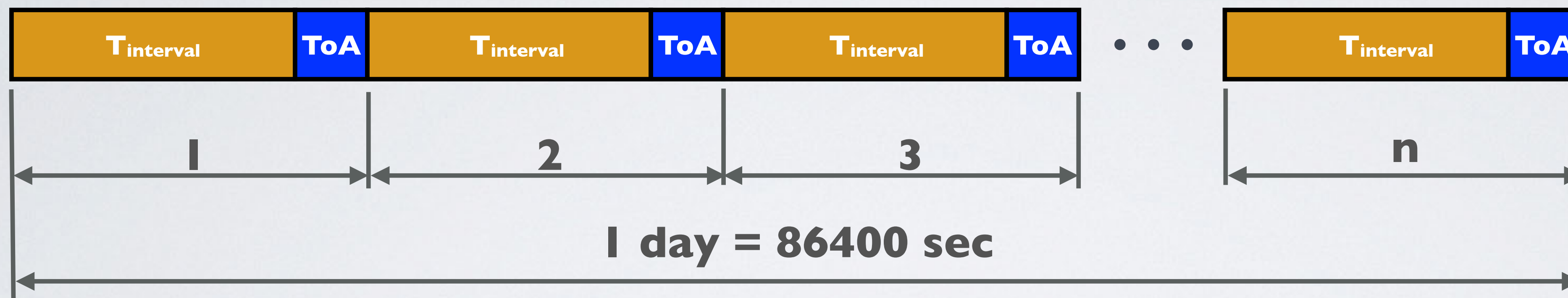
ETSI DUTY CYCLES

- In Europe, for all 8 frequencies, the duty cycle is 1%
- This means, the total allowed uplink Time on Air is $(86400 \times 1\% =)$ **864** sec per day, per device.
- Note: A day has $24 \times 60 \times 60 = 86400$ sec

TTN FAIR ACCESS POLICY

- The Things Network Fair Access Policy is there to make sure that the community network is not abused by large deployments and applies to all of the community network.
- More information about TTN Fair Access Policy can be found at: <https://www.thethingsnetwork.org/docs/lorawan/duty-cycle.html>
- The TTN Fair Access Policy limits the data each end-device can send, by allowing:
 - An average of **30** seconds uplink Time on Air, per day, per device.
 - At most 10 downlink messages per day, including the ACKs for confirmed uplinks.
- Compared to the ETSI duty cycles of 1%, TTN Fair Access Policy is more restrictive because it only allows an average of 30 seconds uplink Time on Air, per day, per device. This is equivalent to a duty cycle of 0.0347 %

TRANSMIT TIME INTERVAL



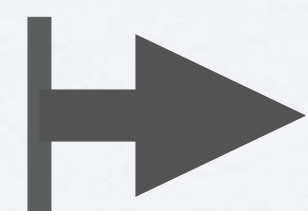
$$n \times (T_{\text{interval}} + ToA) = 86400$$

$$n \times T_{\text{interval}} + n \times ToA = 86400$$

$$n \times T_{\text{interval}} = 86400 - n \times ToA$$

$$T_{\text{interval}} = (86400 - n \times ToA) / n$$

$$\text{DutyCycle} = (n \times ToA) / 86400$$



$$T_{\text{interval}} = (ToA / \text{DutyCycle}) - ToA$$

T_{interval} = Transmit time interval in sec

ToA = Time on Air in sec

n = number of transmissions within a day

A duty cycle is the fraction of one period in which a signal or system is active.

TRANSMIT TIME INTERVAL

- Example 1:

If duty cycle = 1% and ToA=0.05 sec

$$T_{\text{interval}} = (\text{ToA} / \text{DutyCycle}) - \text{ToA}$$

$$T_{\text{interval}} = (0.05 / 0.01) - 0.05 = 4.95 \text{ sec}$$

- Example 2:

If total uplink ToA = 30 sec per day, per device and ToA=0.05 sec

$$\text{DutyCycle} = 30 / 86400 = 0.00034722$$

$$T_{\text{interval}} = (\text{ToA} / \text{DutyCycle}) - \text{ToA}$$

$$T_{\text{interval}} = (0.05 / 0.00034722) - 0.05 = 143.95 \text{ sec}$$

DO I BREAK TTN FAIR ACCESS POLICY?

- Question:

Do I comply with the ETSI duty cycles and The Things Network Fair Access Policy if I keep running the ttn-otaa-mydemo sketch for a day?

Note: In the sketch T_{interval} (TX_INTERVAL) was set to 60 sec.

- Answer:

I only need to focus on TTN Fair Access Policy because it is more restrictive.

TTN Fair Access Policy uses a total uplink ToA of 30 sec per day, per device

ToA=82.432 msec

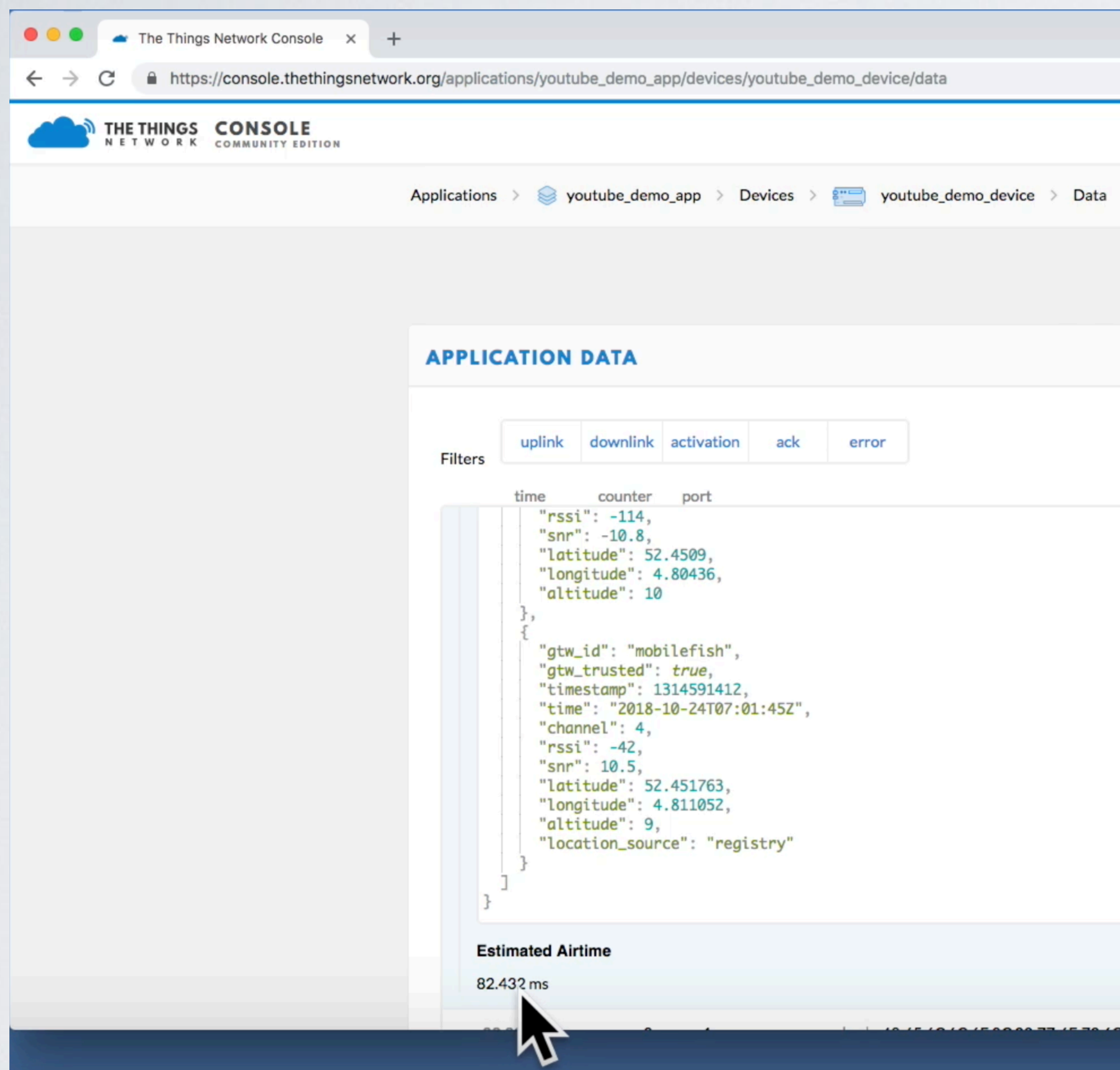
$$\text{DutyCycle} = 30 / 86400 = 0.00034722$$

$$T_{\text{interval}} = (\text{ToA} / \text{DutyCycle}) - \text{ToA}$$

$$T_{\text{interval}} = (0.082432 / 0.00034722) - 0.082432$$

$$T_{\text{interval}} = 237.32 \text{ sec}$$

DO I BREAK TTN FAIR ACCESS POLICY?



The screenshot shows the 'The Things Network Console' interface. The browser address bar displays the URL: `https://console.thethingsnetwork.org/applications/youtube_demo_app/devices/youtube_demo_device/data`. The page title is 'APPLICATION DATA'. Below the title, there are filter buttons for 'uplink', 'downlink', 'activation', 'ack', and 'error'. The main content area displays a JSON object representing application data. The JSON object includes fields for 'time', 'counter', 'port', 'rssi', 'snr', 'latitude', 'longitude', 'altitude', 'gateway_id', 'gateway_trusted', 'timestamp', and 'location_source'. The 'time' field is highlighted in blue. Below the JSON object, the 'Estimated Airtime' is shown as 82.432 ms. A mouse cursor is pointing at the 'Estimated Airtime' value.

Applications > youtube_demo_app > Devices > youtube_demo_device > Data

APPLICATION DATA

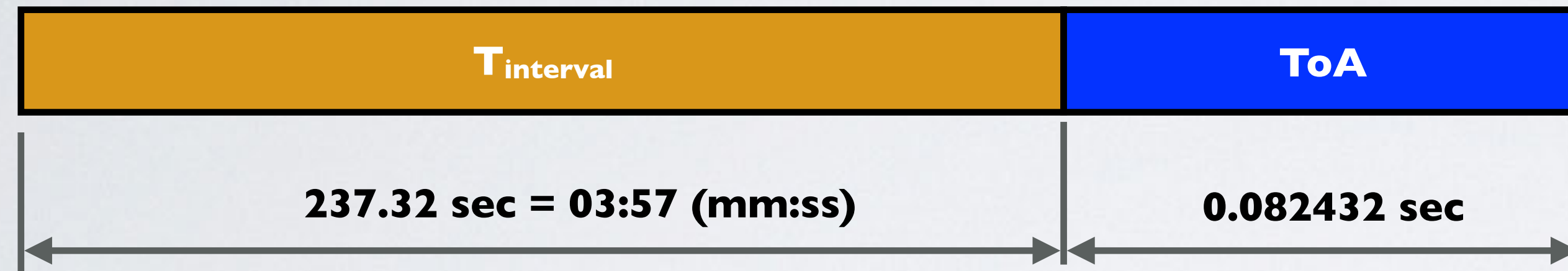
Filters: uplink downlink activation ack error

```
time counter port
{"rssi": -114,
 "snr": -10.8,
 "latitude": 52.4509,
 "longitude": 4.80436,
 "altitude": 10
},
{"gateway_id": "mobilefish",
 "gateway_trusted": true,
 "timestamp": 1314591412,
 "time": "2018-10-24T07:01:45Z",
 "channel": 4,
 "rssi": -42,
 "snr": 10.5,
 "latitude": 52.451763,
 "longitude": 4.811052,
 "altitude": 9,
 "location_source": "registry"
}
]
```

Estimated Airtime
82.432 ms

DO I BREAK TTN FAIR ACCESS POLICY?

- Yes, I will break the TTN Fair Access Policy.



- In the ttn-otaa-mydemo sketch the transmit time interval ($TX_INTERVAL$) is set to 60 sec but it should be 238 sec.
- The above mentioned calculated transmit time interval does not change as long if the payload length and data rate does not change.

WHAT IF THE DATA RATE CHANGED?

- Lets assume the following situation, my gateway went down and the nearest gateway my end device can send messages to is 5 km away.

Data rate = SF12BW125

Code Rate = 4/5

Payload length = 13 bytes ("Hello, world!")

What is the new transmit time interval when using The Things Network?

- Calculate the Time on Air: <https://www.loratoools.nl/#/airtime>

Calculated ToA = 1155.07 ms

- Note:

The online Time on Air tool, shows: One message every 01:56 (mm:ss)

This is based on a duty cycle of 1%

WHAT IF THE DATA RATE CHANGED?

- TTN Fair Access Policy uses a total uplink ToA of 30 sec per day, per device

$$\text{DutyCycle} = 30 / 86400 = 0.00034722$$

$$T_{\text{interval}} = (\text{ToA} / \text{DutyCycle}) - \text{ToA}$$

$$T_{\text{interval}} = (1.15507 / 0.00034722) - 1.15507$$

$$T_{\text{interval}} = 3325.47 \text{ sec} = 55:25 \text{ (mm:ss)}$$