Oyster Sigfox Integration

Revision 1.4 - 26 September 2018

1. REVISION HISTORY

Date	Version	Changes
2017-05-08	1.0	Initial release
2017-06-01	1.1	Corrected *Downlink 2 – Uplink Budgeting Strategy*
2017-06-20	1.2	Corrected typo in callback body
2017-11-20	1.3	Added default downlink values
2018-09-26	1.4	Added extended uplink (*Uplink 3* and bit 7.7 of *Downlink 7*)

2. DEVICE BEHAVIOUR

The Oyster's behaviour can be configured by setting a variety of parameters using a USB programming adapter, or by sending a subset of those parameters during a downlink message. The details of these parameters can be found on the product support website.

2.1. Uplink

The Oyster uses an accelerometer to detect movement, allowing it to decide when an asset is in-trip, and when it is stationary. This allows it to schedule the battery-hungry GPS fixes and transmissions as infrequently as possible, to maximize battery life. Each time a status update is scheduled the Oyster will attempt a GPS fix, then transmit the results (whether the fix succeeded or not). You can configure the Oyster to transmit a status update:

- Periodically (ie. 24-hour heartbeat)
- At the start of a regular or after-hours trip
- During the trip
- At the end of the trip

Since the Sigfox network only allows a limited number of uplinks per billing period, and charges overage fees, the Oyster limits its uploads accordingly. It can be configured to adapt its upload rate dynamically to make better use of unused uploads as the billing period elapses.

2.1.1. Uplink Budgeting

At the beginning of each billing period, the total number of uplinks allowed in that period is reset to match the contract level. The uplink count is then divided up between the days of the billing period, to give a base daily allowance. Each day, the Oyster will limit itself to using no more than either:

1. The sum of unused uplinks from the previous days in the billing cycle, and the current day

Or

2. The sum of unused uplinks from the previous, current, and future days in the billing cycle

The unused uplinks from previous days are considered expendable, and will be used opportunistically to increase the frequency of uplinks during movement.

2.1.2. Device Statistics

The Oyster transmits a device statistics message at most once every 3 days, budget permitting. On the bottom-tier 'One' contract, it sends at most once every 7 days, using 'unused uplinks' from the budget only. The device statistic messages can be disabled to prevent tracking disruption in regions where the transmit duty cycle restrictions are a bottleneck (RCZ1 allows only one transmission every 10 minutes).

2.2. Downlink

The Oyster will request a downlink message a little over once per day on average, to save battery. The downlink request will always be sent on the first uplink after the power is cycled, and thereafter will be sent opportunistically during normal heartbeat and movement uplinks. When a parameter update is sent down to the Oyster, it responds with an acknowledgement uplink once the uplink budget permits. It always requests a downlink when sending acknowledgements, allowing a second parameter update to occur quickly. No downlink budgeting is performed in terms of the Sigfox contract allowance.
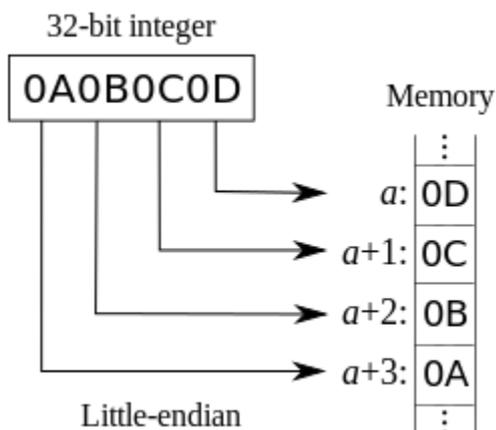
3. MESSAGES

3.1. Number Formats

3.1.1. Little Endian

All data in the payloads is LITTLE ENDIAN. Be aware of this when converting data fields that consist of more than one byte from the data payload.

https://en.wikipedia.org/wiki/Endianness#Little

3.1.2. Signed (Negative) Numbers

Signed numbers are represented in "two's complement" form. Be aware of this when converting signed fields from the data payload.

https://en.wikipedia.org/wiki/Two's_complement

3.2. **Uplink**

Sigfox permits us a maximum of a 12 byte payload in the uplink message. The network sends the Sigfox device serial number so it is not needed in our payload.

3.2.1. Uplink Type

The first 4 bits of the uplink determine the rest of the uplink layout.

Offset	Description
0.0 - 0.3	Uplink type

3.2.2. Uplink Type 0: GPS Data Record

NB: Data is Little Endian

Offset	Description
0.0 - 0.3	Message type = 0
0.4	In-trip
0.5	Last fix failed
0.6 - 0.7	Reserved, set to zero
1 (INT32)	32 bit latitude, **signed**, LSb = 0.000'000'1°. To convert, first calculate the signed integer value, then divide by 10 million to get a floating-point value.
5 (INT32)	32 bit longitude, **signed**, see above
9 (BYTE)	Heading, LSb = 2°
10 (BYTE)	Speed, LSb = 1 km/h
11 (BYTE)	Battery voltage, LSb = 25 mV

3.2.3. Uplink Type 1: Downlink Ack

Offset	Description
0.0 - 0.3	Message type = 1
0.4	0: Downlink rejected, 1: Downlink accepted
0.5 - 1	Reserved, set to zero
2	Firmware major version
3	Firmware minor version
4 (BYTE[8])	Verbatim copy of downlink payload

3.2.4. Uplink Type 2: Device Statistics

Offset	Description
0.0 - 0.3	Message type = 2
0.4 - 1.4	Uptime, LSb = 1 week
1.5 - 2.7	Tx count, LSb = 32 Tx attempts

3	Rx count, LSb = 32 Rx attempts
4.0 - 5.4	Trip count, LSb = 32 trips
5.5 - 6.6	GPS Successes, LSb = 32 fixes
6.7 - 7.6	GPS Failures, LSb = 32 failed fixes
7.7 - 8.7	Average fix time, calculated over successful fixes only, seconds
9.0 - 10.0	Average fail time, calculated over failed fixes only, seconds
10.1 - 11.0	Average freshen time per successful fix, seconds
11.1 - 11.7	Wakeups per trip

3.2.5. Uplink Type 3: Extended GPS Data

This uplink is sent in place of uplink 0 when configured (see downlink 7).

Offset	Description
0.0 - 0.3	Message type = 3
0.4 - 0.7	Heading, LSb = 22.5°, rounded to nearest
1.0 - 3.7	24 bit latitude, **signed**, LSb = 0.000'025'6°. To convert, first calculate the signed integer value, then multiply by 256E-7 to get a floating-point value.
4.0 - 6.7	24 bit longitude, **signed**, see above
7 (BYTE)	Position accuracy, LSb = 1 m
8 (BYTE)	Battery voltage, LSb = 25 mV
9.0 - 9.5	Speed, LSb = 2.5 km/h
9.6	In-trip
9.7	Last fix failed
10 - 11	Reserved, set to zero

3.3. **Downlink**

The downlink has an 8 byte payload. Download reception is not acknowledged at the link layer, so the Oyster queues an explicit downlink acknowledgement uplink (type 1) on reception. Downlinks are supported by firmware versions 1.3 and higher.

3.3.1. Downlink Type

The first byte of the downlink determines the rest of the downlink layout.

Offset	Description
0 (BYTE)	Downlink type

3.3.2. Downlink Type 0: Set Sigfox Plan

Offset	Description
0 (BYTE)	Downlink type = 0

1 (UINT16)	Device pin to authorise downlink, '1234' BCD coded as 0x12, 0x34, may be factory set unique pin, or custom pin
3 (UINT16)	New custom pin, '1234' BCD coded as 0x12, 0x34, disable with 0xFFFF
5 (INT8)	Offset of normal billing time zone from UTC, LSb = 15 minutes, default 0
6.0 - 6.3	Contract level, 0: One / 1: Silver / 2: Gold / 3: Platinum, 4-15: Reserved, default Platinum
6.4 - 7	Reserved, set to zero

The Oyster is provisioned with a unique random factory pin at production, and the custom pin is left blank (0xFFFF). The Oyster will accept a new Set Sigfox Plan message if:

- The supplied pin matches the factory pin, OR
- The supplied pin matches the custom pin, OR
- The custom pin is blank (0xFFFF)

If the message is accepted, the custom pin is updated to the new pin.

3.3.3. Downlink Type 1: Reserved

This downlink type is reserved for future use.

3.3.4. Downlink Type 2: Set Trip Parameters

Offset	Description
0 (BYTE)	Downlink type = 2
1 (BYTE)	Max time between fix attempts out of trip ('heartbeat'), 1-127: 1-127 mins, 129-255: 1-127 hours, default 24 hours
2 (BYTE)	Trip end timeout, LSb = 10s without accelerometer detecting movement, 0 disables trip tracking entirely (heartbeats only), default 5 mins
3 (BYTE)	Time between fix attempts in-trip when using base uplink budget during work hours, 1-127: 1-127 seconds, 129-255: 1-127 minutes, 0 or 128 disables, default 10 mins
4 (BYTE)	Time between fix attempts in-trip when using extra (rollover) uplink budget during work hours, 1-127: 1-127 seconds, 129-255: 1-127 minutes, 0 or 128 disables, <= base budget duration, default 0
5 (BYTE)	Time between fix attempts in-trip when using base uplink budget after hours, 1-127: 1-127 seconds, 129-255: 1-127 minutes, 0 or 128 disables, default 1 hour
6 (BYTE)	Time between fix attempts in-trip when using extra (rollover) uplink budget after hours, 1-127: 1-127 seconds, 129-255: 1-127 minutes, 0 or 128 disables, <= base budget duration, default 0
7.0	Fix on start of trips during work hours, default true
7.1	Fix on end of trips during work hours, default true
7.2	Fix on start of trips after hours, default true
7.3	Fix on end of trips after hours, default true

Offset	Description
7.4	Optimise GPS for trip tracking (download all ephemerides), default true
7.5	Require 3D GPS fixes, default true
7.6 - 7.7	Uplink budgeting strategy, 0: Daily, 1: Monthly, 2-3: Reserved, default daily

3.3.5. Downlink Type 3: Set After-Hours Mon-Thur

Offset	Description
0 (BYTE)	Downlink type = 3
1 (BYTE)	Start of after-hours period on Monday, LSb = 7m30s since 00:00 local time, setting to end time indicates no after-hours period, default 0
2 (BYTE)	End of after-hours period on Monday, LSb = 7m30s since 00:00 local time, setting to start time + 1 indicates a 7m30s after-hours period, set start time to 00:00 and end time to 24:00 to indicate the whole day is after-hours, default 0
3 (BYTE)	Start of after-hours period on Tuesday, see above
4 (BYTE)	End of after-hours period on Tuesday, see above
5 (BYTE)	Start of after-hours period on Wednesday, see above
6 (BYTE)	End of after-hours period on Wednesday, see above
7 (BYTE)	Start of after-hours period on Thursday, see above

3.3.6. Downlink Type 4: Set After-Hours Thur-Sun

Offset	Description
0 (BYTE)	Downlink type = 4
1 (BYTE)	End of after-hours period on Thursday, LSb = 7m30s since 00:00 local time, setting to start time + 1 indicates a 7m30s after-hours period, set start time to 00:00 and end time to 24:00 to indicate the whole day is after-hours, default 0
2 (BYTE)	Start of after-hours period on Friday, LSb = 7m30s since 00:00 local time, setting to end time indicates no after-hours period, default 0
3 (BYTE)	End of after-hours period on Friday, see above
4 (BYTE)	Start of after-hours period on Saturday, see above
5 (BYTE)	End of after-hours period on Saturday, see above
6 (BYTE)	Start of after-hours period on Sunday, see above
7 (BYTE)	End of after-hours period on Sunday, see above

3.3.7. Downlink Type 5: Set After-Hours Time Zone

Offset	Description
0 (BYTE)	Downlink type = 5
1.0 - 1.1	Reserved, set to zero

1.2 - 2.1	Offset of normal time zone from UTC, LSb = 15 minutes, **signed**, default 0
2.2 - 2.5	Daylight saving time shift, LSb = 15 minutes, 0 disables, default 0
2.6 - 3.0	Start of DST Nth day of month, 1: First day, …, 5: Fifth day, 6: Last day, 0: Use absolute date instead of relative '2nd Sunday of October' style
3.1 - 3.5	1-7: Monday-Sunday, or 1-31: Day of month (absolute date), local time
3.6 - 4.1	1-12: January-December
4.2 - 5.2	Offset from 00:00 local time, LSb = 15 mins, **signed**, can select hours in previous days like '02:00 on Friday before last Sunday of October local time' would need Offset = (2hr - 48hr) * 4 = -184
5.3 - 5.5	End of DST Nth day of month, 1: First day, …, 5: Fifth day, 6: Last day, 0: Use absolute date instead of relative '2nd Sunday of October' style
5.6 - 6.2	1-7: Monday-Sunday, or 1-31: Day of month (absolute date), local time
6.3 - 6.6	1-12: January-December
6.7 - 7.7	Offset from 00:00 local DST, LSb = 15 mins, **signed**, can select hours in previous days like '02:00 on Friday before last Sunday of April local DST' would need Offset = (2hr - 48hr) * 4 = -184

3.3.8. Downlink Type 6: Set Accuracy and Wakeup Parameters

Offset	Description
0 (BYTE)	Downlink type = 6
1 (BYTE)	Max time to wait for initial coarse GPS fix, 45-127: 45-127 seconds, 129-255: 1-127 minutes, default 5 mins
2 (BYTE)	Max time to wait for fine GPS fix, 1-127: 1-127 seconds, 129-255: 1-127 minutes, 0 or 128 disables, default 5 s
3 (BYTE)	Target accuracy for the fine GPS fix wait, LSb = 1m, default 20 m
4 (BYTE)	Required PDOP for valid GPS, 25-100: 2.5 to 10.0, default 5.0
5 (BYTE)	Required position accuracy for valid GPS, 5-100: 5-100 m, default 50 m
6 (BYTE)	Accelerometer wakeup threshold, 1-8: 63-504 mG, default 126 mG
7 (BYTE)	Accelerometer wakeup count, 0-12: 0-960 ms, default 80 ms

3.3.9. Downlink Type 7: Set Advanced Parameters 1

Offset	Description
0 (BYTE)	Downlink type = 7
1 (BYTE)	Required speed accuracy for valid GPS, 8-55: 2.88-19.8 km/h, default 10 km/h
2 (BYTE)	Daily GPS on-time budget, 45-127: 45-127 seconds, 129-255: 1-127 minutes, 0 or 128 for unlimited on-time budget, default unlimited
3 (BYTE)	Max time to spend looking for 1st satellite, 1-255: 5-1275s, 0 disables signal validator, default 1 min

4 (BYTE)	Max time to spend looking for 2nd satellite, 0-255: 0-1275s, default 1 min
5 (BYTE)	Max time to spend looking for 3rd satellite, 0-255: 0-1275s, default 1 min
6 (BYTE)	Max time to spend looking for 4th satellite, 0-255: 0-1275s, default 1 min
7.0 - 7.4	Satellite detection margin adjustment, **signed**, -16-15: -16-15 dB, >=0 requires stronger signal, <0 allows weaker signal, 0 is default
7.5	Disable wakeup debounce filtering, 1: only apply accelerometer wakeup threshold and count, 0: apply threshold, count, and slow debounce filter, default 0
7.6	Disable stats messages (uplink 2), 0 is default (message enabled)
7.7	Send *Extended GPS Data* (uplink 3) instead of uplink 0, 0 is default

3.3.10. Downlink Type 8: Set Advanced Parameters 2

Offset	Description
0 (BYTE)	Downlink type = 8
1 (BYTE)	GPS *Static Hold Threshold*, filters out slow wander, LSb = 1 cm/s, 0 disables (default), deprecated
2 (BYTE)	GPS statistical model, 0: Portable, 2: Stationary,3: Pedestrian, 4: Automotive, 5: Sea, 6: Air 1G, 7: Air 2G, 8: Air 4G, default 4
3 (BYTE)	Discard first N GPS points to allow solution to settle, 0-32: 0-32 positions, default 3
4 (UINT16)	Approximate maximum error from Autonomous Aiding calculations, 5-1000: 5-1000 m, 0: automatic, default: 100
6.0	Enable Autonomous Aiding, default off
6.1 - 7	Reserved, set to zero

3.3.11. Downlink Type 255: Set Generic Parameter

Offset	Description
0 (BYTE)	Downlink type = 255
1 (UINT16)	Parameter set identifier
3 (BYTE)	Parameter offset
4 (BYTE[4])	Raw parameter data

This is a test command that can be used to write small values directly into the parameter memory of the Oyster. It is documented here for completeness, but is not intended for general use. Abuse of this downlink may modify or erase the parameters of the Oyster.

4. GATEWAY SETUP

In order to set up a new callback for Telematics Guru Live you will need the following settings on backend.sigfox.com:

Type:	DATA BIDIR
Channel:	URL
Send duplicate:	OFF
Custom payload config:	<BLANK>
Url pattern:	http://telematics.guru:8081/
Use HTTP Method:	POST
Send SNI:	OFF
Headers:	<BLANK>
Content type:	application/json

Body:

```
{
        "device":"{device}",
        "time":{time},
        "duplicate":{duplicate},
        "snr":{snr},
        "station":"{station}",
        "data":"{data}",
        "avgSnr":{avgSnr},
        "lat":{lat},
        "lng":{lng},
        "rssi":{rssi},
        "seqNumber":{seqNumber},
        "ack":{ack}
}
```

5. CONTACT INFORMATION

For the latest version of this document plus other product information please visit our website at www.digitalmatter.com/support, or contact DM at info@digitalmatter.com.