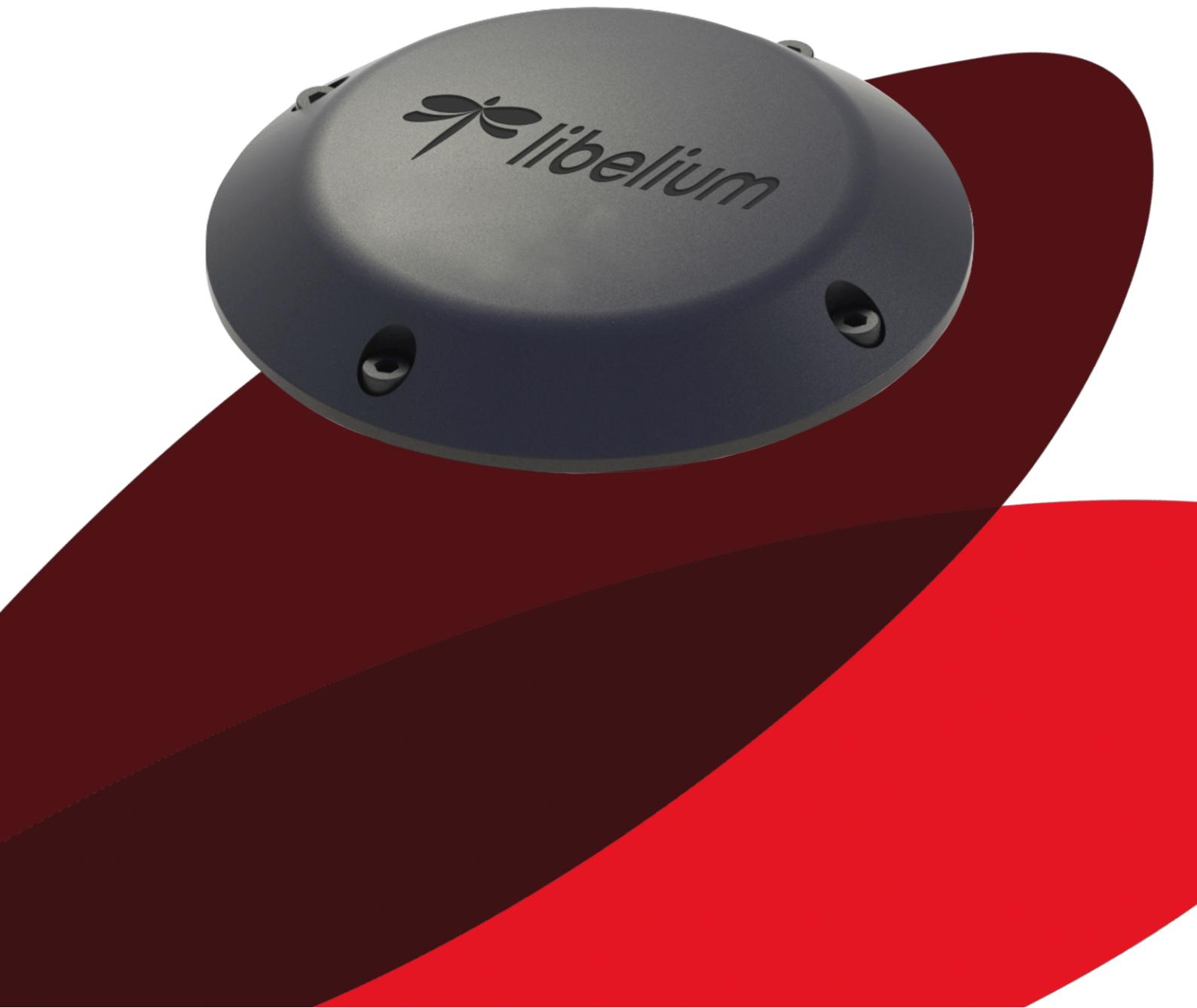




Smart Parking

Technical Guide



Contents

1	Introduction	3
2	Network architecture	6
2.1	Smart Parking node	6
2.2	LoRaWAN base station	6
2.3	LoRaWAN Network Server	7
2.4	Libelium Cloud	7
3	Smart Parking node	8
3.1	Hardware description	8
3.1.1	Node versions	9
3.1.2	Firmware versions	9
3.1.3	LoRaWAN regions	10
3.1.4	LoRaWAN protocol and parameters	10
3.1.5	Identification label	11
3.2	Power and time consumption	11
3.2.1	Smart Parking EU	11
3.2.2	Smart Parking US	11
3.3	User switches	12
3.4	Reset button	12
3.5	Node setup	13
3.5.1	“Ready to install” state	13
3.5.2	How to close the Smart Parking node	13
3.5.3	“Magnet start-up” process	14
3.6	How the node works	15
3.6.1	Frame types	15
3.6.2	Node program execution	17
3.7	Node parameters	17
3.7.1	Parameters description and ranges	17
3.7.2	Understanding Info and Keep-alive frames	18
3.7.3	Understanding night-mode	19
3.7.4	Understanding RTC synchronization	20
3.7.5	Understanding uplink frames format (real example)	21
3.7.6	Factory default values	21
3.7.7	Configure new parameter values	22
4	Smart Devices App	23
4.1	Configuring Smart Parking v2 parameters	23
4.1.1	How to plug the Smart Parking node	23
4.1.2	Configuration	23
4.1.3	Programmer (change node parameters)	25
4.1.4	Firmware upgrade	26
4.1.5	Factory Reset	27
5	LoRaWAN Network Server setup	29
5.1	Loriot	29
5.1.1	Log in	29
5.1.2	Create a new Loriot application	29
5.1.3	Output data: Libelium Cloud URL	30
5.1.4	How to delete unused Loriot applications	32
5.1.5	How to create a single device manually	32
5.1.6	Nodes batch provisioning in Loriot	33
5.2	Actility	34
5.2.1	How to create a new Application Server	35

5.2.2 How to create a new AS routing profile	36
5.2.3 How to create new devices manually	38
5.2.4 Nodes batch provisioning in Actility	40
5.3 Libelium Base Station	42
5.3.1 Supported LoRa Network Servers	42
5.3.2 Configure LoRaWAN Network Settings	42
5.3.3 Register the gateway in Loriot	43
6 Cloud system	46
6.1 Libelium Cloud	46
6.2 FIWARE	46
6.3 Client third party platform	47
7 Deployment and installation	49
7.1 Step-by-step guideline	49
7.2 How to place the nodes	49
7.3 Node installation	50
7.3.1 On-surface node installation	51
7.3.2 Semi-underground node installation	55
7.4 Node start-up	57
7.5 Working example	58
7.6 How to replace the battery	59
8 Certifications	60
8.1 CE (European Union)	60
8.2 FCC (United States)	60
8.3 UKCA (UK)	60
8.4 IP68 (EN 60529)	60
8.5 IK10 (EN 50102)	60
9 Maintance	61
10 Disposal and recycling	62
11 Safety Guides	63
11.1 Smart Parking Chemical Fixing Cartridge	64
12 Documentation changelog	76

1 Introduction

The Smart Parking v2 solution developed by Libelium allows citizens to detect available parking slots.



Figure 1.0.1: Smart Parking node developed by Libelium

The Smart Parking device applies intelligent algorithms to detect changes in the state of the parking slot. Then data is transmitted across the LoRaWAN infrastructure to the LoRaWAN Network Server. Finally, the information is delivered to a final Cloud system.

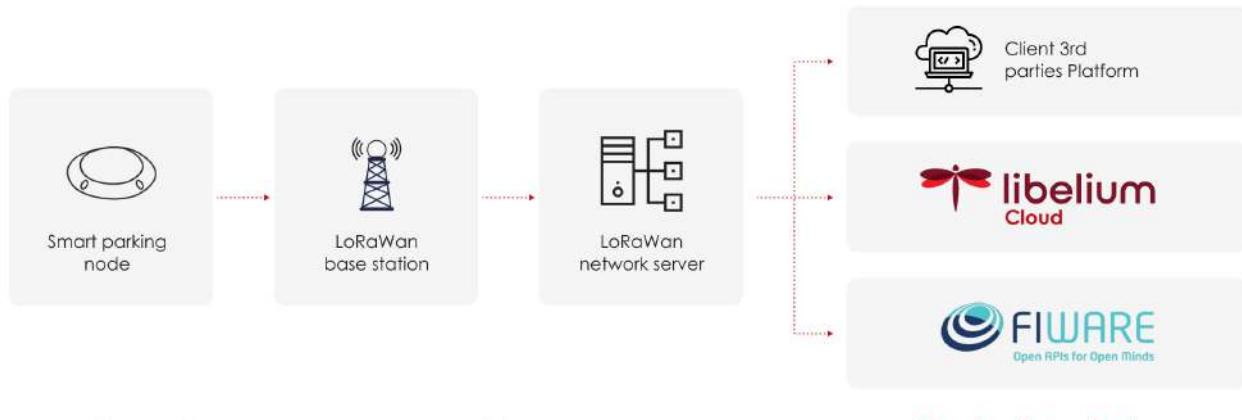


Figure 1.0.2: Smart Parking architecture

One of the next Cloud system possibilities are available:

- **Libelium Cloud** (SaaS solution): Cloud provided by Libelium which allows the user to remotely configure the node parameters (sleep time, keep-alive, night-mode, etc). That makes it possible to directly install the nodes with factory default settings and then update them from the server side. Both Loriot and Actility LoRaWAN Network Servers are supported. Also, visualization maps and Cloud connectors are provided.

- **FIWARE** (On-premise solution): FIWARE-based platforms are supported always that ChirpStack LoRaWAN Network Server is used. If FIWARE platform is already provided by the client, then frame decoding and data treatment are provided by Libelium. On the other hand, a full FIWARE installation in the user's system is provided when needed.
- **Client third party platform** (On-premise solution): Any Cloud or platform developed by the user which could provide database, visualization etc. In this scenario the LoRaWAN Network Server connection must also be developed. Frames decoding documentation is provided to the client when this option is chosen.

Feature	Libelium Cloud	FIWARE	Client 3rd party platform
Server hosting	SaaS	On-premise	On-premise
Network Server	Loriot or Actility	ChirpStack	Any integrated by the Client
Visualization	Yes	Yes	Must be developed by the Client
Remote configuration	Yes	No	Must be developed by the Client

The devices' **provisioning** is very simple. The nodes are delivered with default program settings and unique LoRaWAN identifiers and keys. So it is easy to use the default settings to register all nodes in the LoRaWAN network server at a time.

The Smart Parking node provides an outstanding detection performance thanks to its radar sensor. The next table shows a comparative analysis of the current sensor technologies in the Smart Parking market:

	Radar	Infra-red	Magnetometer
Reliability against nearby vehicle movement	✓	✓	✗
Reliability against nearby parked vehicles	✓	✓	✗
Reliability against electromagnetic interferences	✓	✓	✗
Reliability in any lighting scenario	✓	✗	✓
Stability during long-duration vehicle stays	✓	✓	✗
Do not need an aperture in enclosure	✓	✗	✓
Immunity against dirt or dust on enclosure	✓	✗	✓

Libelium Cloud remote parameter configuration:

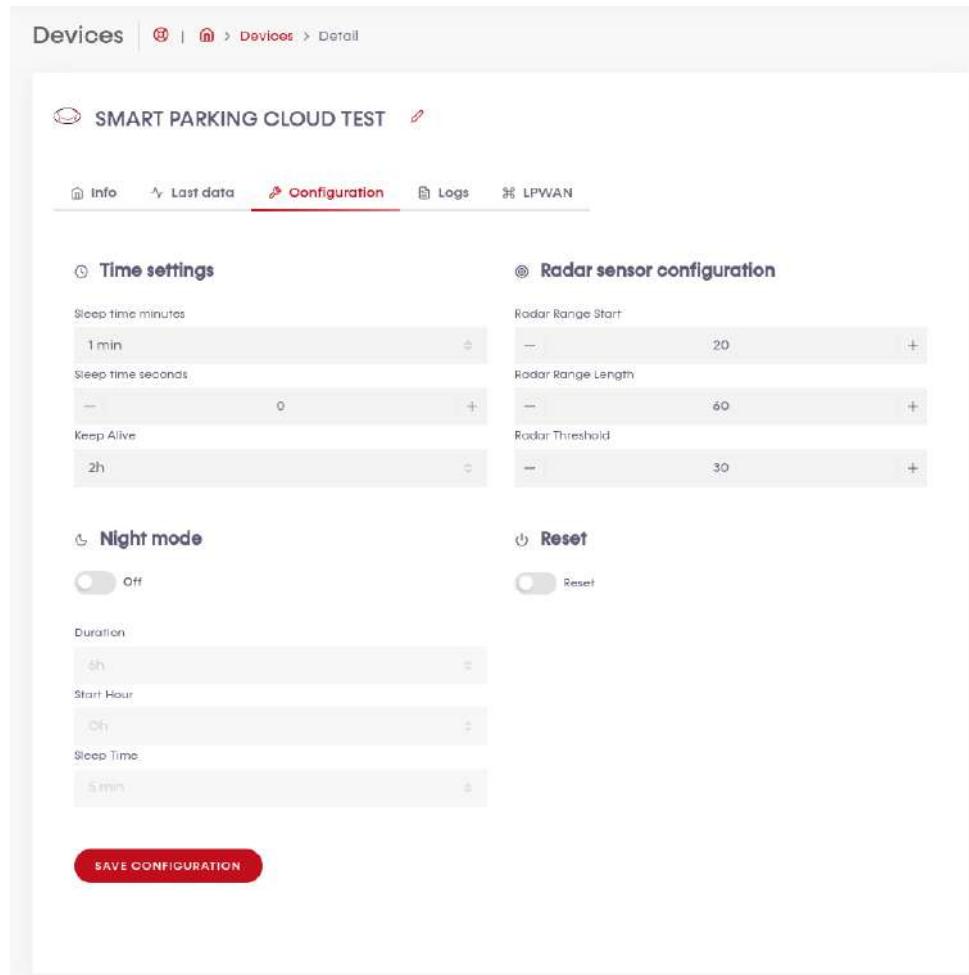


Figure 1.0.3: Libelium Cloud remote parameter configuration

2 Network architecture

The network architecture of Smart Parking is based on the next elements:

- Smart Parking node
- LoRaWAN base station
- LoRaWAN Network Server
- Libelium Cloud



Figure 2.0.1: Architecture of Libelium's Smart Parking solution

2.1 Smart Parking node

The Smart Parking node is the device installed in each parking slot. When the device detects a change of the parking slot status (free/occupied), it sends a frame to the LoRaWAN base station.



Figure 2.1.1: Smart Parking node

2.2 LoRaWAN base station

The LoRaWAN base station (also known as gateway) must be installed in the surrounding area next to the parking nodes. It receives data and forwards it to the LoRaWAN Network Server. Libelium distributes base stations for LoRaWAN networks. All of them have LoRaWAN connection; some feature Ethernet, WiFi or 4G connectivity too. Some base stations are ready to work outdoors (IP67 grade). Some of them come pre-

configured for certain LoRaWAN network servers (see next section). Also, some of them integrate an embedded LoRaWAN Network Server.



Figure 2.2.1: LoRaWAN base station

2.3 LoRaWAN Network Server

The nodes registration must be done in the Network Server in order to receive LoRaWAN data from all nodes in the network. Each node must be registered with an identifier and some encryption keys so the Network Server can receive and decrypt the packets successfully.

The LoRaWAN Network Server purpose is to translate data from the LoRaWAN wireless network to an IP network. Therefore, when Smart Parking nodes packets are received, a callback is performed in order to send data to Libelium Cloud.

2.4 Libelium Cloud

The LoRaWAN Network Server connects to the final server: Libelium Cloud.

Libelium Cloud permits to receive, decode, store and exploit data. The user can also redirect data to a 3rd party IoT cloud (Amazon Web Services, Microsoft Azure, etc). This retransmission is done thanks to the cloud connectors running on Libelium Cloud.

In addition, Libelium Cloud allows the user to update the settings of each parking node (sleep time, keep-alive time, night-mode, etc). The update is done remotely via LoRaWAN downlink radio packets.



Figure 2.4.1: Where Libelium Cloud sits in the complete solution

3 Smart Parking node

3.1 Hardware description

The Smart Parking node is based on 2 different pieces: the base and the external enclosure. The base of the Smart Parking node includes the PCB, the battery, the antenna and the internal enclosure piece. The base is screwed to the external enclosure piece.

The next table shows the basic Smart Parking node characteristics.

Enclosure dimensions	200 x 200 x 37.25 mm
Enclosure materials	Polyamide, polypropylene and glass fiber
Weight	0.813 kg (including installation accessories) 0.540 kg (just the Smart Parking node)
Power supply	Built-in lithium-thionyl chloride (Li-SOCl2) batteries; expected lifetime of 4-10 years*
Configurable sleep time	Min: 10 s / max: 10 min
Radio protocol	LoRaWAN module
Dual detection	Radar (main) and magnetic (backup)
Provisioning	Ready to install (factory LoRaWAN OTAA IDs and key are pre-configured to each node)
Node configuration	Via Libelium Cloud
LoRaWAN configuration	Via “Smart Devices App” (Java desktop application)
Operating temperature	-20 to +65 °C
Market certifications	CE (Europe) FCC (USA) UKCA
Ingress protection certification	IP68 (maximum rating against dust and water ingress)
Impact protection certification	IK10 (maximum rating against impacts)

(*) Under normal circumstances and depending on settings

(**) Continuous operation in extreme temperatures (high or low) is not recommended for long periods of time – for example, this may lead to reduced battery capacity, lower radar performance or random resets

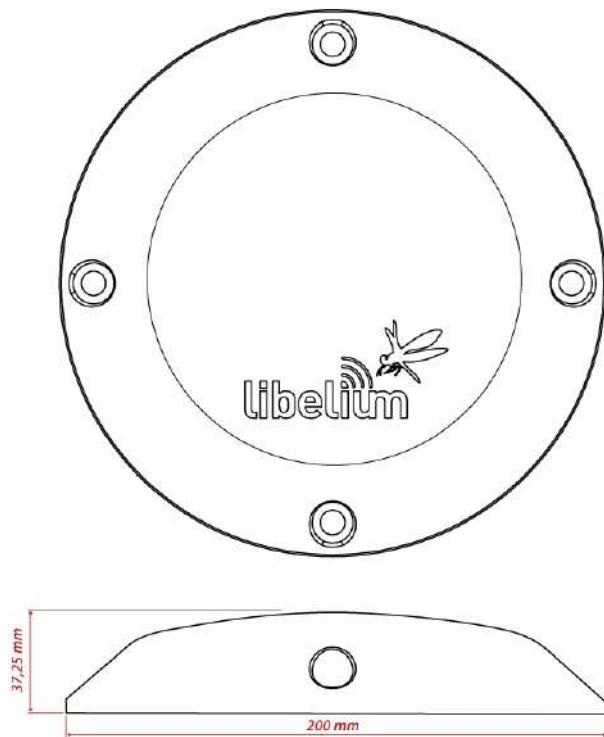


Figure 3.1.1: Vaulted enclosure dimensions

The radar sensor performs a re-calibration process periodically to deliver the most accurate measurement. It is an automatic feature, so no user action is required. Besides, this re-calibration is internal, meaning it is always completed correctly, regardless of whether there is a vehicle above the node or not.

3.1.1 Node versions

Libelium provides the next versions of Smart Parking:

Reference	Version	Operating frequency
SP-EU	Smart Parking EU	863.0 to 870.0 MHz (LoRaWAN EU863-870)
SP-US	Smart Parking US	902.0 to 928.0 MHz (LoRaWAN US902-928)
SP-APLA-AU	Smart Parking APAC/LATAM/AU/AU915	915.2 to 927.8 MHz (LoRaWAN AU915-928)
SP-IN	Smart Parking IN	865.0 to 867.0 MHz (LoRaWAN IN865-867)
SP-APLA-AS	Smart Parking APAC/LATAM/AU/AS923	923 MHz (LoRaWAN AS923)

3.1.2 Firmware versions

Firmware versions of Smart Parking nodes:

Firmware version	Description
v1.0.x	First Smart Parking node versions (deprecated)
v1.1.1	First stable release in v1.1.x generation
v1.1.2	Minimum sleep time from 20 to 10 seconds
v1.1.3	Fixed LoRaWAN US manufacturer issues
v1.1.4	Improved sensor measurement with high temperatures

Firmware version	Description
v1.2.0	Improved power consumption in bad coverage behaviour and doubtful states. Update in frame header: re-calibration bit to doubtful detection

3.1.3 LoRaWAN regions

The Smart Parking node supports the next LoRaWAN regions:

LoRaWAN region	Supported by
EU 863-870 MHz ISM Band (Europe)	Smart Parking EU
US 902-928 MHz ISM Band (United States)	Smart Parking US
AU 915-928 MHz ISM Band (Australia)	Smart Parking APAC / LATAM / AU / AU915
IN 865-867 MHz ISM Band (India)	Smart Parking IN
AS 923 MHz ISM Band (Asia and ASEAN region)	Smart Parking APAC / LATAM / AU / AS923
CN 779-787 MHz ISM Band (China)	Not available
CN 470-510 MHz ISM Band (China)	Not available
KR 920-923 MHz ISM Band (South Korea)	Not available
433 MHz ISM Band (Worldwide)	Not available

If you are interested in further information about LoRaWAN country regulations, please refer to the [LoRa Alliance regional parameters document](#).

3.1.4 LoRaWAN protocol and parameters

LoRaWAN is a Low Power Wide Area Network (LPWAN) protocol. It is a spread-spectrum modulation technique at extremely low data-rates which permits sending data achieving long ranges.

The most important LoRaWAN parameters are:

- LoRaWAN EUI: Read-only, 8-byte, unique identifier which defines each LoRaWAN module in the market.
- Device EUI: Read/write, 8-byte identifier configured into the LoRaWAN module to be used as operating identifier. By default, the “LoRaWAN EUI” of the module is factory-configured as “Device EUI” in the Smart Parking node.
- Join mode: ABP or OTAA. Defines how the module joins the network. Different keys are needed for each method.
- Device address: Needed for ABP. The 4-byte address of the the LoRaWAN module. Must be unique in its own sub-network.
- Network Session Key: Needed for ABP. The 16-byte AES key. Used to generate Message Integrity Check.
- Application Session Key: Needed for ABP. The 16-byte AES key. Used to encrypt data.
- Application EUI: Needed for OTAA. The 8-byte application identifier. Needed for opening an OTAA session and exchange encryption keys.
- Application Key: Needed for OTAA. The 16-byte key. Needed for opening an OTAA session and exchange encryption keys.
- Data-rate: Defines the transmission rate (bits per second). Each data-rate settings combines different Spreading Factor (SF) and bandwidth (BW). By default, all LoRaWAN regions use the same data-rate (DR 0). However, depending on the region, that means different SF and BW:
 - LoRaWAN EU863-870 version: SF12 / 125 kHz
 - LoRaWAN IN865-867 version: SF12 / 125 kHz
 - LoRaWAN AS923 version: SF12 / 125 kHz
 - LoRaWAN US902-928 version: SF10 / 125 kHz
 - LoRaWAN AU915-928 version: SF10 / 125 kHz
- ADR: Adaptive Data Rate setting which can be enabled or disabled. If ADR is enabled, the server will optimize the data-rate based on the information collected from the network: the RSSI / SNR of the last received packets.

If you are interested in further information about LoRaWAN specifications, please refer to the [LoRa Alliance specifications document](#).

3.1.5 Identification label

There is a sticker on the bottom side of the Smart Parking node base. In this sticker, several device specifications can be seen. For example the “Model” which refers to the device’s region. Also, the unique “LoRaWAN EUI” is displayed so each node can be distinguished.



Figure 3.1.2: Smart Parking node label

3.2 Power and time consumption

The Smart Parking node firmware executes different steps since the node is started. Firstly, the node’s setup and then an infinite loop where every cycle is based on measuring, sending if needed and sleeping. The next tables show the power and time consumption of each step modelled as a pulse of a specific time duration and average power consumption.

3.2.1 Smart Parking EU

	Power consumption	Time consumption
Node setup	22.9 mA	59 s
Measure cycle	26 mA	340 ms
Measure and send cycle	17 mA	6 s
Sleep cycle	5.5 uA	Depends on sleep time settings

(*) LoRaWAN EU is set to the default SF12 settings (worst case). The send process may be lower power if the node is close to the base station.

3.2.2 Smart Parking US

	Power consumption	Time consumption
Node setup	21.8 mA	53 s
Measure cycle	26 mA	340 ms
Measure and send cycle	20 mA	3.6 s
Sleep cycle	5.5 uA	Depends on sleep time settings

(*) LoRaWAN US is set to the default SF10 settings (worst case). The send process may be lower power if the node is close to the base station.

3.3 User switches

The Smart Parking node has 2 switches to manage the working mode:

- **On/Off** switch: Determines whether the node is powered-on or powered-off
- **App/Boot** switch: When the node is powered-on, this switch determines the performance state of the device
 - App position must be used for a normal operation mode, so the device executes the firmware within it
 - Boot position must be used for configuring purposes only



Figure 3.3.1: Smart Parking node “users switches”

When the node is powered-on (On switch), you can change from App to Boot or viceversa by changing the state of the App/Boot switch. However, you must press the reset button to apply the operation mode change. Another possibility to successfully change the operation mode step-by-step would be to: power down the device (Off switch), change the App/Boot switch, press the reset button and then power on the device.

Never leave the device set to On and Boot for more time than needed. The bootloader does not provide any sleep mode and it will waste the battery of the device. So when you finish reconfiguring the device, please set the node in off state.

3.4 Reset button

The reset button can be used to re-start the node in the corresponding operation mode (App or Boot). If the node is set up to “App” (normal operation mode), pressing the reset button will re-start the program execution. On the other hand, if the node is set up to Boot (configuration mode), pressing the reset button will re-start the MCU bootloader for reconfiguration or firmware update.



Figure 3.4.1: Reset button

3.5 Node setup

3.5.1 “Ready to install” state

Libelium provides the nodes “ready to install” so the user only needs to install the nodes and follow the “[Magnet start-up](#)” process.

The Smart Parking node has a power-on process in order to put the device into a “ready-to-install” state:

- Step 1: The switches are set to “App” and “Off” (press the reset button to make sure you discharge capacitors)
- Step 2: You power the device on by sliding the switch from “Off” to “On”
- Step 3: Both LEDs (red and green) blink rapidly for 5 times
- Step 4: Red LED blinks once for 1 second to indicate that the device enters sleep mode for the 1st time. Now the node is in a “ready to install” state. The customer should install the node on the real scenario and perform the “Magnet start-up” process.



Figure 3.5.1: “Ready-to-install” LED indication

You can see how the previous steps are performed in this video: [Ready to install process](#)

3.5.2 How to close the Smart Parking node

After following the previous steps, the device can be closed. In order to close the node correctly and ensure correct sealing, the following steps must be strictly followed.

- Step 1: Make sure that the screws have the o-rings to prevent water ingress.



Figure 3.5.2: Screw with o-ring

- Step 2: Ensure that the top surface of the gasket is clean and contains no foreign objects.
- Step 3: Place the inner casing inside the outer casing and make sure that the 2 position marks match.



Figure 3.5.3: Enclosure position marks

- Step 4: Insert the screws and tighten them halfway.



Figure 3.5.4: Screws in their position

- Step 5: Finally, tighten the 4 screws firmly. Do not use the maximum pressure (do not go all the way with the screws), because the o-rings could be ejected from the screws, and then the waterproof feature would NOT be valid. Besides, do not screw too hard and keep on screwing, because the screws could carve the female sockets, expanding their inner diameter; this would cancel the waterproof quality too.

Libelium manufactures and provides all nodes configured after following all explained steps, so the node is “ready to install”. By factory default, all nodes are configured with their unique LoRaWAN EUI and random private keys. On the other hand, if different LoRaWAN parameters are desired, “[SmartDevicesApp](#)” must be used to change the settings and repeat the previously explained steps.

3.5.3 “Magnet start-up” process

Once the node has been set to “ready to install” state and it has been closed and placed on the parking slot, the “magnet start-up” must be done. This process consists on resetting the device using the magnet for 3 consecutive times. Each magnet reset must be separated by at least one second period.

The best way to proceed with the magnet is to go over the enclosure from left to right in a one-motion movement. Then wait for at least one second (although you can wait more) and proceed again until you complete 3 magnet resets.



Figure 3.5.5: Magnet reset

In the next video-clip you can see how the “magnet start-up” is performed: [Magnet start-up](#)

After finishing the “magnet start-up”, the node starts working normally for the rest of the time. No more three-time “magnet resets” are needed in order to reset the device properly. So if a 4th magnet reset or software reset is applied, the device will reset and continue working normally again.

The “magnet start-up” is only mandatory when the node is powered from a power-off state. In other words, when the device is set to a “ready to install” state.

3.6 How the node works

3.6.1 Frame types

The Smart Parking architecture manages different uplink and downlink frames. The next table shows the uplink frames:

Frame type	Description
Start frame 1	First frame sent by the node when starting (with params settings)
Start frame 2	Second frame sent by the node when starting (with params settings)
Info frame	Used to inform a Parking Status change
Keep-alive frame	Used to inform the device keeps working since last reported status
Configuration uplink	Used to confirm a “Configuration downlink” was applied or not
RTC update request	Used to request for an RTC sync once every day

The next table shows the downlink frames:

Frame type	Description
Configuration downlink	Used to update the node parameters. After the customer sets up a new node configuration in the Remote Configuration Form a new “Configuration downlink” frame is enqueued into the LoRaWAN network server’s downlink queue.
RTC sync frame	Used to sync the node’s RTC to the server’s timestamp. It is the mandatory response to “Start frame 1” and “RTC update request” uplink frames.

The uplink frames are 11-byte long to always comply with the LoRaWAN datarate worst case scenario. Their structure consists on 2 parts: header and payload. The “header” format is always the same for all uplink frame types. On the other hand, the “payload” format may be different for each frame type.

Regarding the downlink frames, they have variable length and its format is private to the customer. The “RTC sync frame” is the mandatory response for both “Start Frame 1” and “RTC update request” frames. The “RTC sync frame” provides the server time to the nodes in order to keep the RTC updated. Also, the “Configuration downlink” is an asynchronous frame sent by the server when the Remote Configuration Form is managed by the customer.

You must keep in mind that when a downlink packet is requested there are usually some issues related to LoRaWAN network latency. This implies that the 1st request attempt usually fails. In that case, a 2nd attempt is sent in order to retrieve the lost downlink packet. For this reason, you might see that a couple of “Start Frame 1” or “RTC update request” frames are sent sequentially during the execution of the program.

Libelium Cloud has the needed code to parse data inside frames into a more comprehensive structure. The cloud connectors also provide the needed tools to transmit the parsed data to a 3rd party IoT cloud.

3.6.2 Node program execution

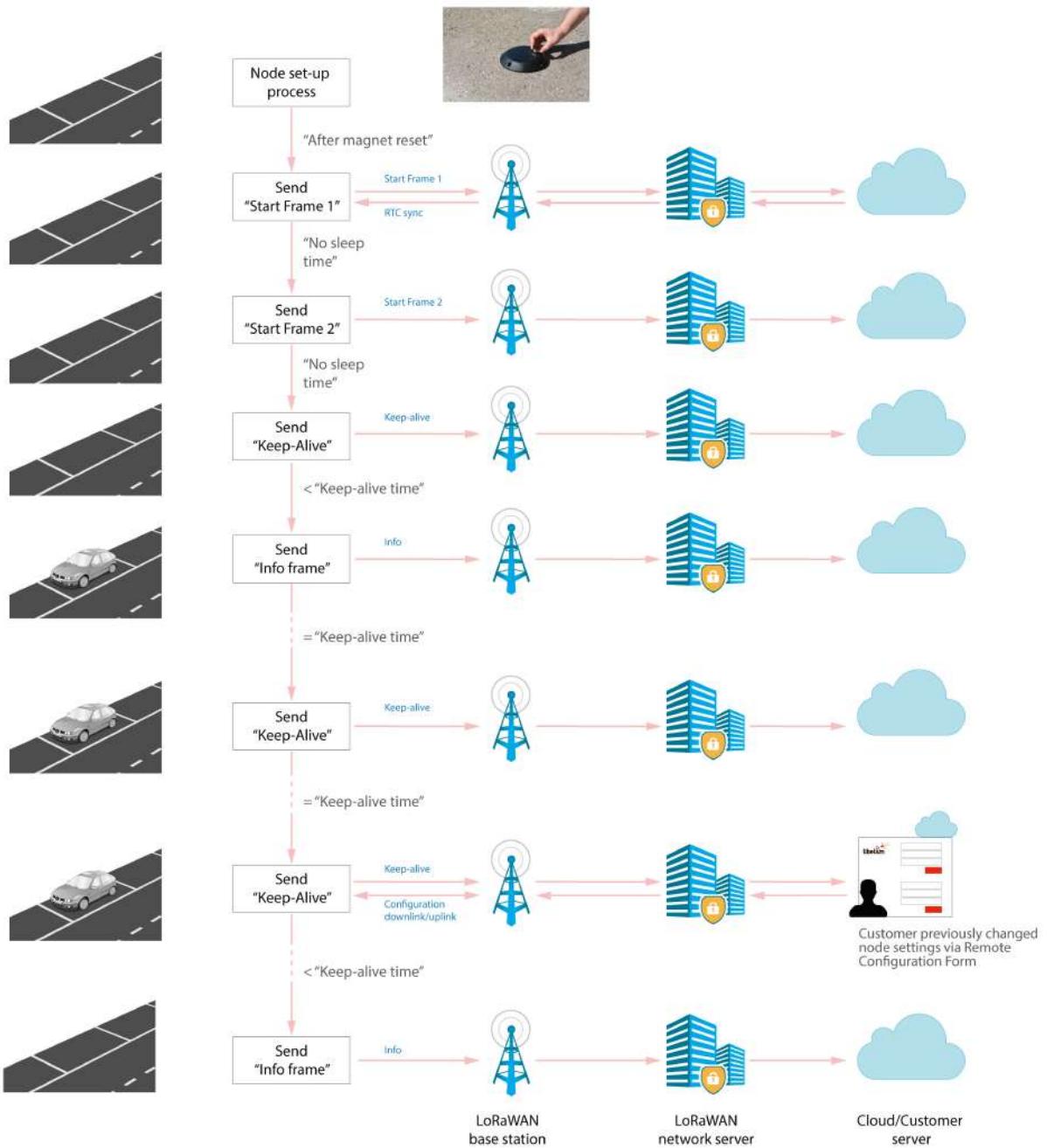


Figure 3.6.1: Smart Parking node program flow chart

3.7 Node parameters

3.7.1 Parameters description and ranges

The Smart Parking node has different parameters that change the timing and detection performance of the node. The next table shows the node parameters:

Parameter	Range	Description
Sleep time	1-10 min or 10-59 s	Minutes or seconds elapsed between each measurement cycle
Keep-alive time	0.5, 1, 2,..., 23 hour	Hours elapsed since last uplink message which triggers a new Keep-alive frame
Night-mode	0 or 1	Night-mode disabled/enabled
Night-mode start	0, 1,..., 23 hour	Night-mode starts when RTC reaches this parameter field
Night-mode duration	1, 2,..., 15 hour	Night-mode period is equal to this field
Night-mode sleep	1, 2,..., 10 min	Sleep time applied during night-mode
Radar range start	20 to 50 cm	Starting measurement distance (objects below this value are not detected)
Radar range length	50 to 100 cm	Range of measurement to be added to “range start” value
Radar threshold	10 to 50	Threshold used in detection algorithm, so higher threshold imply less sensitive detection
LoRaWAN join mode	0 (ABP) or 1 (OTAA)	Join mode used by the LoRaWAN radio module
LoRaWAN DevEUI	8-byte identifier	Defines the device EUI used by the LoRaWAN radio
LoRaWAN DevAddr	4-byte identifier	Defines the device address used by the LoRaWAN radio in ABP mode
LoRaWAN NwkSKey	16-byte key	Defines the LoRaWAN Network Session Key used by the LoRaWAN radio in ABP mode
LoRaWAN AppSKey	16-byte key	Defines the LoRaWAN Application Session Key used by the LoRaWAN radio in ABP mode
LoRaWAN AppKey	16-byte key	Defines the LoRaWAN Application Key used by the LoRaWAN radio in OTAA mode
LoRaWAN AppEUI	8-byte identifier	Defines the LoRaWAN Application EUI used by the LoRaWAN radio in OTAA mode
LoRaWAN port	1 to 223	Defines the port used for uplink sendings
LoRaWAN ADR	0 (off) or 1 (on)	Defines if Adaptive Data Rate is enabled or disabled
LoRaWAN RX1 Delay	0 to 65536	Defines the delay after first LoRaWAN rx window
LoRaWAN Subband	8-bit bitmap	Defines the sub-band used by the LoRaWAN radio (only applies to US and AU versions)

The LoRaWAN identifiers and keys must be registered in the LoRaWAN network server before starting the node in order to receive data. For OTAA mode: DevEUI, AppEUI and Appkey. For ABP mode: DevEUI, DevAddr, NwkSKey and AppSKey.

3.7.2 Understanding Info and Keep-alive frames

In the regular working mode (day-mode), “Sleep” and “Keep-alive” parameters are used. So the node normally sleeps for a specific “Sleep” time then wakes-up, measures and applies the algorithm detection in order to detect changes in the parking slot.

If a change is detected from ‘free’ to ‘occupied’ or viceversa, then an “Info” frame is sent. If no change occurred during the last “Keep-alive” time, then a Keep-alive frame is sent. Besides, if a sensor error is detected, a Keep-alive frame sending is forced in order to inform about this issue.

Example parameters used:

- Sleep: 7 minutes

- Keep-alive: 1 hour

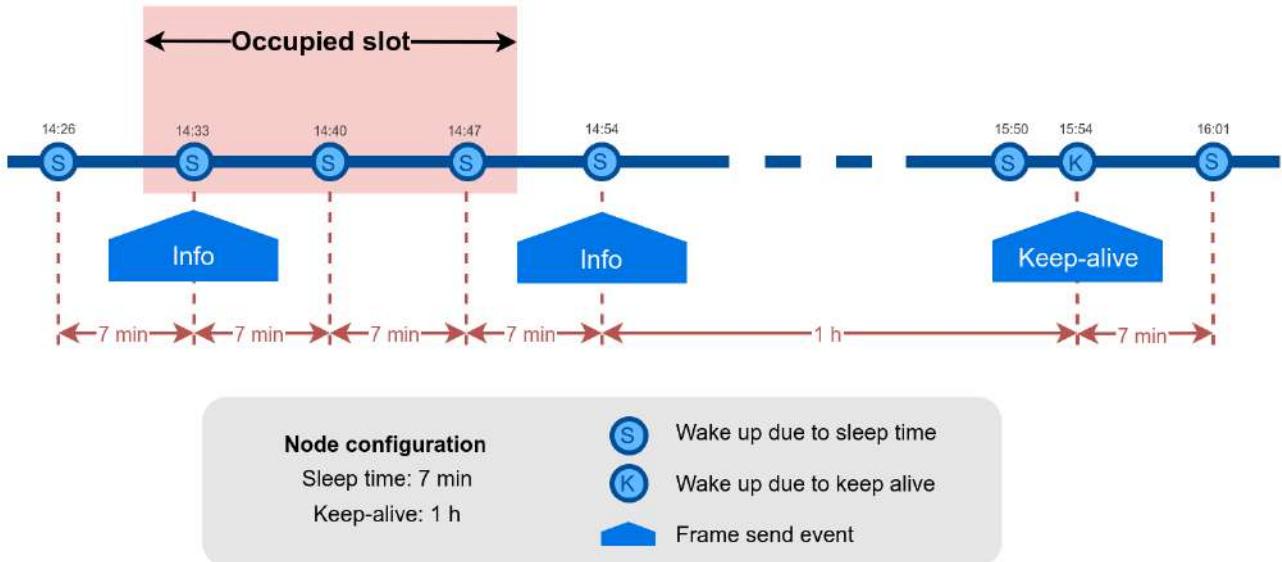


Figure 3.7.1: Example Info and Keep-alive frames

3.7.3 Understanding night-mode

As shown in the parameters table, there are some parameters that allow the user to configure the node to use 2 working modes depending on time settings: day-mode and night-mode.

The night-mode is a secondary and optional working mode that allows the user to configure a different time basis parameters in order to reduce the battery impact. So, it was developed to use it when the parking slot is expected to have fewer changes (i.e. at night). Therefore, a different night-mode “Sleep” setting is used.

It is not mandatory to use the night-mode during night. This mode is thought to be used when less vehicle movement is expected in the parking slots. Which could be during day time.

Example:

- Day-mode:
 - Sleep: 1 minute
- Night-mode:
 - Night-mode start hour: 21 hours (9 PM)
 - Night-mode duration: 10 hours (Night-mode goes from 9 PM to 7 AM)
 - Night-mode sleep time: 10 minutes

In the example, from 9 PM to 7 AM, the node will waste less battery because measurements are done every 10 minutes instead every minute. Keep-alive events are not shown but a Keep-alive event would be triggered if no change occurs in the parking slot.

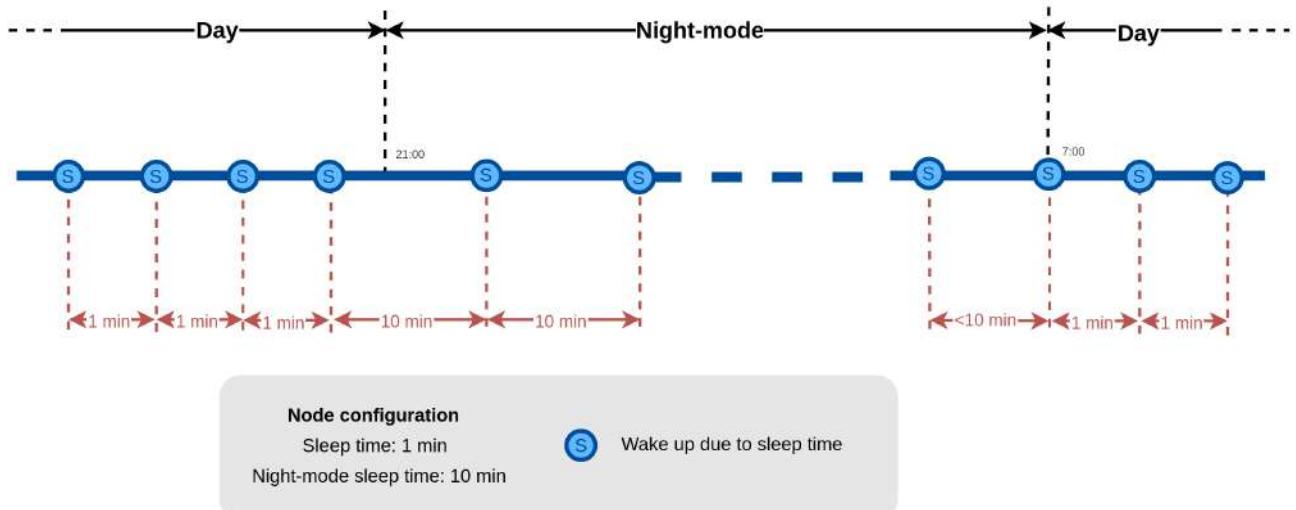


Figure 3.7.2: Example of day and night mode

The conclusion is that the Night-mode is interesting for customers who certainly know the parking slot is expected to have fewer changes during large periods of time every day.

From October 2019 the “keep-alive night-mode” setting was deprecated to simplify the parameter management. Since then, there is a single keep-alive setting, for both “normal mode” and “night mode”.

3.7.4 Understanding RTC synchronization

There are specific frame types that allow the node to synchronize the RTC to the server timestamp.

The “Start Frame 1” expects an answer from the server with the timestamp (hours and minutes). This frame is sent after starting the node or a software reset.

Besides, the node’s firmware provides a mechanism which an “RTC update request” frame is sent every 24 hours since the node was started or reset. This frame waits for a downlink frame which brings the current server timestamp (hour and minutes).

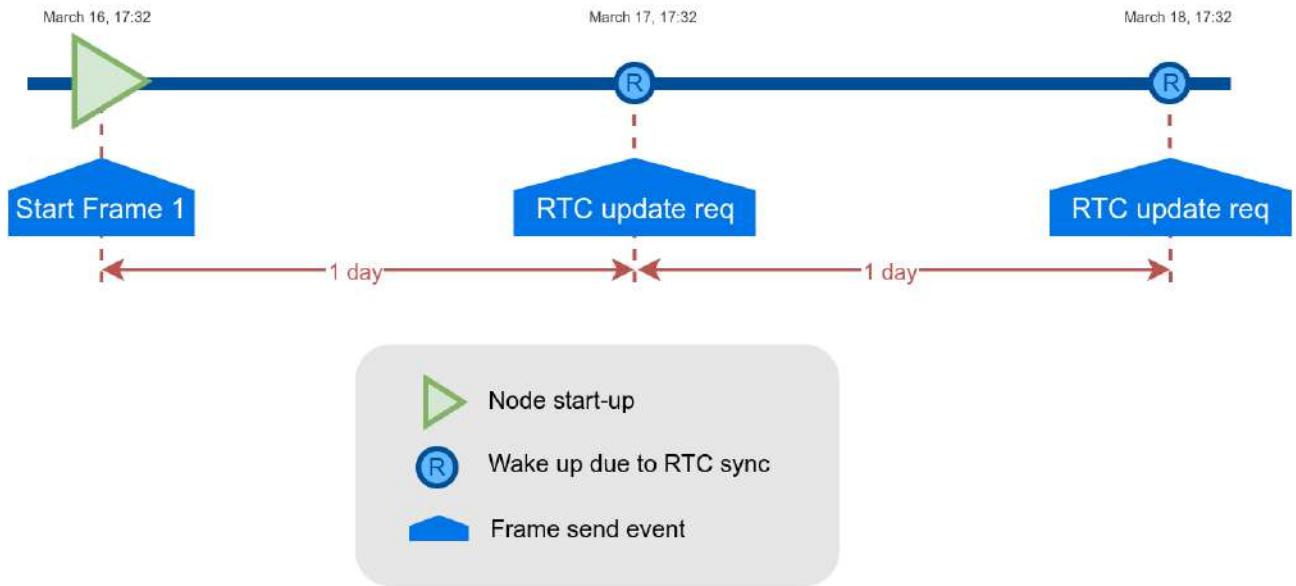


Figure 3.7.3: Example of RTC sync

The RTC sync is important for Night-mode only where it mandatory to operate with a correct timestamp in order to enter and exit from night-mode to day-mode and viceversa.

3.7.5 Understanding uplink frames format (real example)

The next table shows all frames sent by a single node since it was started. The different columns display the parsed data from the received “uplink data”.

Example:

- Day-mode:
 - Sleep: 1 minute
 - Keep-alive: 2 hour
- Night-mode:
 - Night-mode start hour: 22 hours (10 PM)
 - Night-mode duration: 8 hours (Night-mode goes from 10 PM to 6 AM)
 - Night-mode sleep time: 5 minutes

It is possible to distinguish the starting frames at the beginning of the execution. Then the node informs with a new Keep-alive every 2 hours. Any change of Parking slot status implies a new Info frame. And after 24 hours working, you can see the RTC request performed by the node.

Timestamp	F. Type	Parking lot	Battery	Seq
04/15/19 15:59	4 (Start 1)	Not available	0	0
04/15/19 15:59	5 (Start 2)	Not available	0	1
04/15/19 15:59	1 (Keep-alive)	Free	0	2
04/15/19 17:29	1 (Keep-alive)	Free	0	3
04/15/19 19:29	1 (Keep-alive)	Free	0	4
04/15/19 21:29	1 (Keep-alive)	Free	0	5
04/16/19 23:29	1 (Keep-alive)	Free	0	6
04/16/19 01:29	1 (Keep-alive)	Free	0	7
04/16/19 03:29	1 (Keep-alive)	Free	0	8
04/16/19 05:29	1 (Keep-alive)	Free	0	9
04/16/19 06:04	0 (Info)	Occupied	0	10
04/16/19 08:04	1 (Keep-alive)	Occupied	0	11
04/16/19 10:04	1 (Keep-alive)	Occupied	0	12
04/16/19 12:04	1 (Keep-alive)	Occupied	0	13
04/16/19 14:05	1 (Keep-alive)	Occupied	0	14
04/16/19 15:58	7 (RTC request)	Occupied	0	15
04/16/19 15:59	7 (RTC request)	Occupied	0	16
04/16/19 17:59	1 (Keep-alive)	Occupied	0	17
04/16/19 18:32	0 (Info)	0	0	18
04/16/19 20:02	1 (Keep-alive)	0	0	19
04/16/19 22:32	1 (Keep-alive)	0	0	20
04/17/19 00:02	1 (Keep-alive)	0	0	21

3.7.6 Factory default values

Libelium provides all Smart Parking nodes with factory default parameters.

Parameter	Default value
Sleep time	1 min
Keep-alive time	2 hour
Night-mode	0 (disabled)
Night-mode start	0 hour
Night-mode duration	6 hour
Night-mode sleep	5 min

Parameter	Default value
Radar range start	20 cm (should not be changed)
Radar range length	60 cm (should not be changed)
Radar threshold	30 (should not be changed)
LoRaWAN join mode	1 (OTAA)
LoRaWAN DevEUI	unique factory default value
LoRaWAN DevAddr,	unique factory default value
LoRaWAN NwkSKey	unique factory default value
LoRaWAN AppSKey	unique factory default value
LoRaWAN AppKey	unique factory default value
LoRaWAN AppEUI	unique factory default value
LoRaWAN port	3
LoRaWAN ADR	0 (off)
LoRaWAN RX1 Delay	1000 (should not be changed)
LoRaWAN Subband	8-bit bitmap

3.7.7 Configure new parameter values

Both Smart Devices App and Libelium Cloud allow the user to update program parameters to the node:

- **Smart Devices App:** it is a desktop Java application which implies opening the node enclosure and plug a micro-USB cable to the node (the new configuration is flashed to the node's memory via the USB cable).
- **Libelium Cloud:** permits to remotely change some of the node parameters.

Regarding the time and sensor parameters, the same values are set to all nodes manufactured by Libelium. The default values can be seen in the previous section. However, the customer can configure the time and sensor settings using both Smart Devices App and Remote Configuration Form.

Regarding the LoRaWAN parameters, all keys are randomly generated for each node and kept secret. The DevEUI set to the node is the LoRaWAN hardcoded EUI which is unique for each radio chipset. However, the client can configure/modify all LoRaWAN parameters using the Smart Devices App only (the Remote Configuration Form does not permit it).

For further information about this matter please refer to the “[Smart Devices App](#)” section.

4 Smart Devices App

Smart Devices App is a software tool developed by Libelium that allows users to install new firmware versions and program the configuration of Libelium devices in few clicks.

For further information (installation and execution) please refer to Smart Devices App manual: [Smart Devices App \(Binaries Updates\)](#)

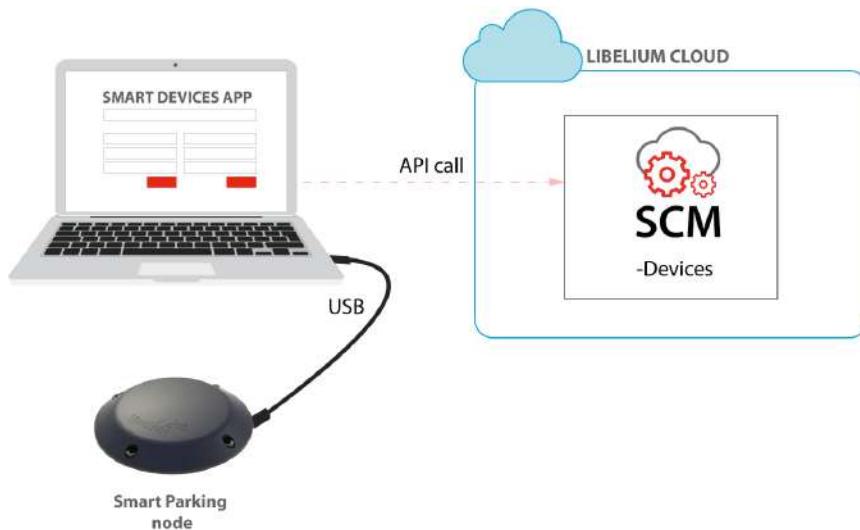


Figure 4.0.1: Smart Devices App is connected to the node via USB

4.1 Configuring Smart Parking v2 parameters

4.1.1 How to plug the Smart Parking node

Before using the Smart Devices App, you must keep in mind how to plug and initialize it properly.

As explained in the “Smart parking node” section, there are 2 switches to manage the node working mode. In order to use the node with the Smart Devices App, it is mandatory to set the node in “Boot” mode and then power it on. If you changed from “App” to “Boot” mode, then you can use the reset button to apply the change and restart the node in the bootloader section.

Never leave the device set to “On” and “Boot” for more time than needed: the bootloader does not provide any sleep mode and it will waste the battery of the device. So when you finish reconfiguring the device, please set the node to “Off” state.

4.1.2 Configuration

In the last tab, called **Configuration**, 2 parameters are available: “Username” and “Password”. These are the same credentials needed for the Libelium Cloud (<https://cloud.libelium.com/app/login>).

Filling these fields is mandatory before start using the Smart Devices App with the Smart Parking node. Please remember to click the “Save” button at the bottom of the application to store the correct credentials.

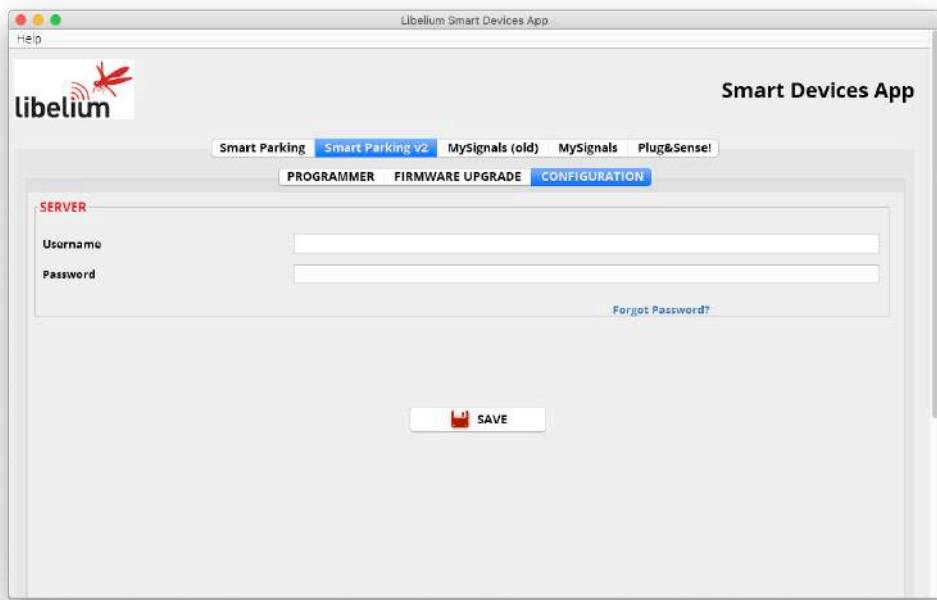


Figure 4.1.1: Configuration screen on Smart Parking v2

There are some differences between the 1st version and the 2nd one. In you must type your credentials to authenticate your nodes against the Libelium Cloud.

You should have an account on the Libelium Cloud to get your username and password.

4.1.3 Programmer (change node parameters)

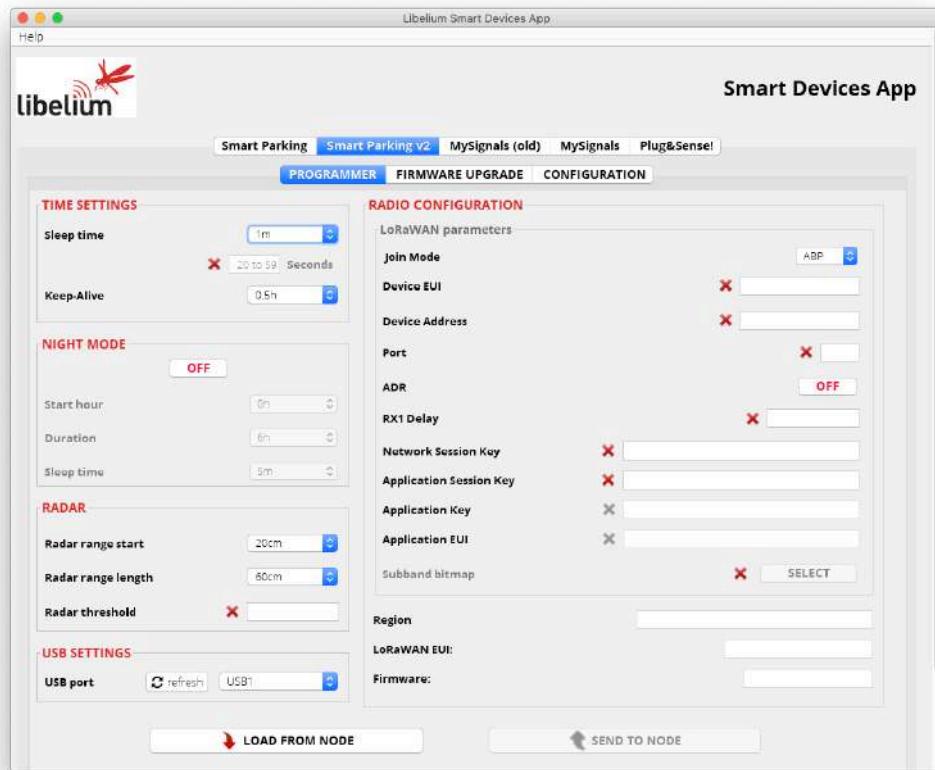


Figure 4.1.2: Smart Parking v2 Programmer section

Users can read and write all node parameters in this section. The process is quite simple: just connect the device to the computer where it is installed using the USB cable provided and switch on the node in “Boot” mode.

Next, refresh the “USB settings” section (bottom-left corner), clicking the “Refresh” button. Then select the port where the device has been connected. After that it is a good practice to hit the “Load from node” button to get the current configuration from the connected device.

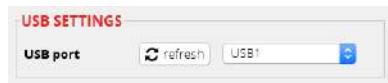


Figure 4.1.3: Smart Parking v2 USB settings

The “Load from node” button will read all parameters from the node and will display the information on the app. On the other hand, the “Send to node” button will overwrite the configuration on the node. All available fields have to be filled with the proper format. If any parameter does not have an acceptable format, a red cross is displayed close to it, and you will not be able to write the information on the node. If the information introduced is valid, a green tick is shown. When loading/sending information to the node, the application will warn the user through a pop-up window about the status of the operation.

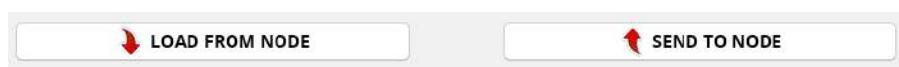


Figure 4.1.4: “Load configuration from node” & “Send configuration to node” buttons

Smart Parking v2 shares most of the configuration fields with . However, it is important to know the purpose for each field on the configuration. To know more about each field and how they work, please refer to the chapter “[Smart Parking node](#)”.

Configuring a “sleep time” less than 1-minute period importantly decrease the battery life.

4.1.4 Firmware upgrade

Inside this tab, users can select the firmware version to install in their devices.

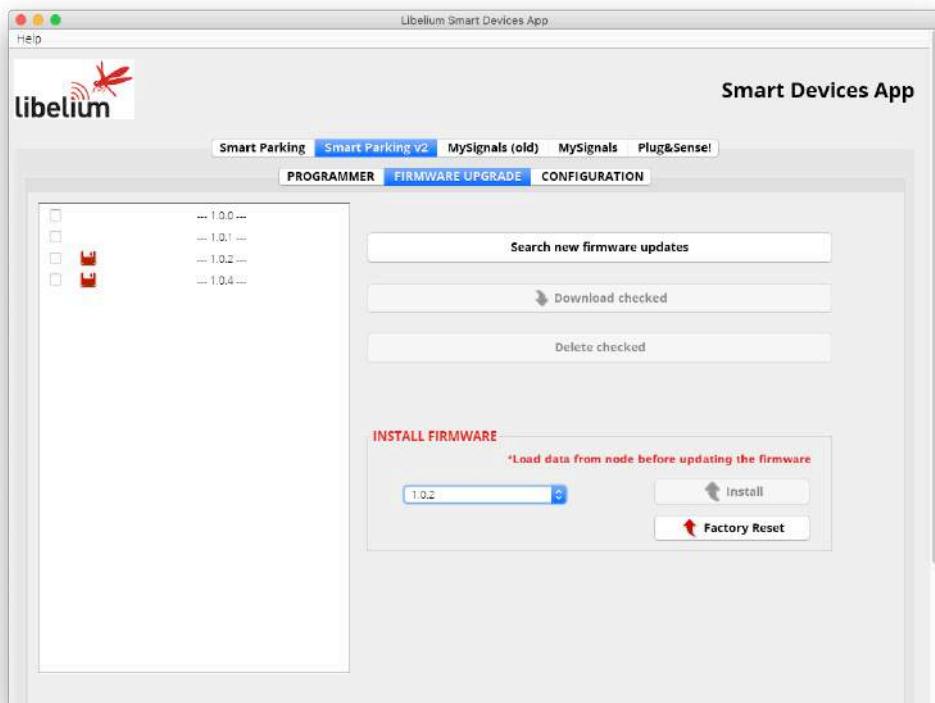


Figure 4.1.5: Firmware update and factory reset section for Smart Parking v2

The list with all available firmware is loaded when the program starts, but users can manually update it by clicking on the “Search new firmware updates” button. Before installing the firmware, it is necessary to download it. This process is very simple, just mark the check of the version you want to install from the list and click on “**Download checked**”.

It is mandatory to perform a configuration load from node using the button available in tab before updating the firmware. This information load will check the current configuration before updating the firmware.

To summarize, the steps are:

1. Check your firmware version in the Programmer tab before flashing a new firmware:
 1. Nodes with firmware v1.1.x are compatible with firmwares v1.1.x and v1.2.x
 2. Nodes with firmware v1.0.x are only compatible with firmwares v1.0.x
2. Click the “Search new firmware updates” button to load new firmware updates
3. Check one or more firmwares to download from the firmware list on the left side
4. Click on “Download checked” to download the selected firmwares



Figure 4.1.6: Download new firmware versions

Now the firmware files are downloaded. The drop-down menu will show the available firmware files to be installed on the node.

When the file is downloaded, a disk icon is displayed close to it, indicating it is downloaded. On the “Install Firmware” section you can select the firmware to install and then hit on “Install” to execute the installation. The app will display a pop-up message for the status of the firmware installation.

Remember that the USB port **must be selected** in the programmer tab.

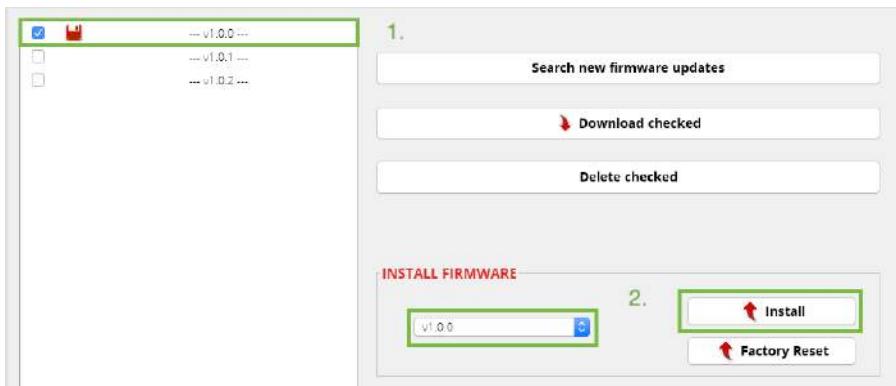


Figure 4.1.7: Firmware installation

You can also delete the downloaded firmware files by selecting the check box from the list and then clicking on the “Delete checked” button.

4.1.5 Factory Reset

The Factory Reset is the last option to recover a non-working Smart Parking v2 device. It performs a full reset followed by a firmware and configuration reset. To get the recovery configuration file, send an e-mail to pointing your order number and the Technical Service Team will send the configuration file needed.

For this process it is mandatory to download a firmware, as explained on the previous section “Firmware upgrade”. Then select a firmware from the drop-down menu and press the “Factory Reset” button.



Figure 4.1.8: Factory reset process for Smart Parking v2 - Step1

Pressing the “Factory Reset” button will display a file explorer window to select the configuration file provided by Libelium. Once you selected this file, a message will show up asking if you want to start the process. If the “Yes” option is selected, the Factory Reset process starts.



Figure 4.1.9: Factory reset process for Smart Parking v2 - Step2

When the Factory Reset finishes, another message informs about the final result:



Figure 4.1.10: Factory reset finished for Smart Parking v2

After this process, you can configure your node again on the “Programmer” tab.

5 LoRaWAN Network Server setup

Libelium currently supports several LoRaWAN Network Server services. In this section, we explain how to set them up.

Remember that any LoRaWAN network needs a Network Server, so you have to choose one of the options above. Not only Libelium's Smart Parking nodes need a Network Server: any LoRaWAN device (by Libelium or other company) needs a Network Server, it's just one piece of the LoRaWAN architecture.

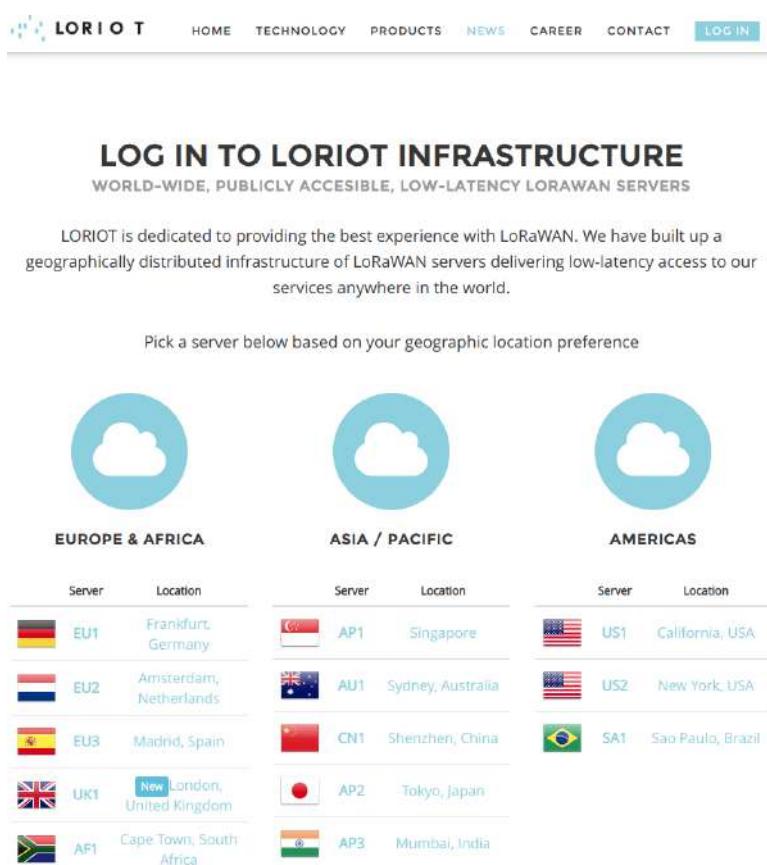
5.1 Loriot

This section explains how to route the information on Loriot to Libelium Cloud using the HTTPS protocol.

The free “Community account” does not permit remote downlinks. Therefore, a Commercial license should be purchased in order to use remote downlink messages for RTC sync, night-mode feature and node parameter update via Remote Configuration Form.

5.1.1 Log in

Log in in the [Loriot platform](#), selecting your server location.



The screenshot shows the Loriot Infrastructure login page. At the top, there is a navigation bar with links for HOME, TECHNOLOGY, PRODUCTS, NEWS, CAREER, CONTACT, and LOG IN. Below the navigation bar, the heading "LOG IN TO LORIOT INFRASTRUCTURE" is displayed, followed by the subtext "WORLD-WIDE, PUBLICLY ACCESIBLE, LOW-LATENCY LORAWAN SERVERS". A descriptive paragraph states: "LORIOT is dedicated to providing the best experience with LoRaWAN. We have built up a geographically distributed infrastructure of LoRaWAN servers delivering low-latency access to our services anywhere in the world." Below this text, a prompt says "Pick a server below based on your geographic location preference". There are three main sections for server selection: "EUROPE & AFRICA", "ASIA / PACIFIC", and "AMERICAS". Each section contains a list of servers with their respective flags and locations.

Region	Server	Location
EUROPE & AFRICA	EU1	Frankfurt, Germany
	EU2	Amsterdam, Netherlands
	EU3	Madrid, Spain
	UK1	New London, United Kingdom
	AF1	Cape Town, South Africa
ASIA / PACIFIC	AP1	Singapore
	AU1	Sydney, Australia
	CN1	Shenzhen, China
	AP2	Tokyo, Japan
	AP3	Mumbai, India
AMERICAS	US1	California, USA
	US2	New York, USA
	SA1	Sao Paulo, Brazil

Figure 5.1.1: Loriot login web page

5.1.2 Create a new Loriot application

Once you selected the server location, a new prompt will be displayed asking your credentials. After logging in, users have to create a new application in the Loriot dashboard. To do this it is necessary to click on “Appli-

cations” in the left side bar and then in “New Application” option located in the same bar:

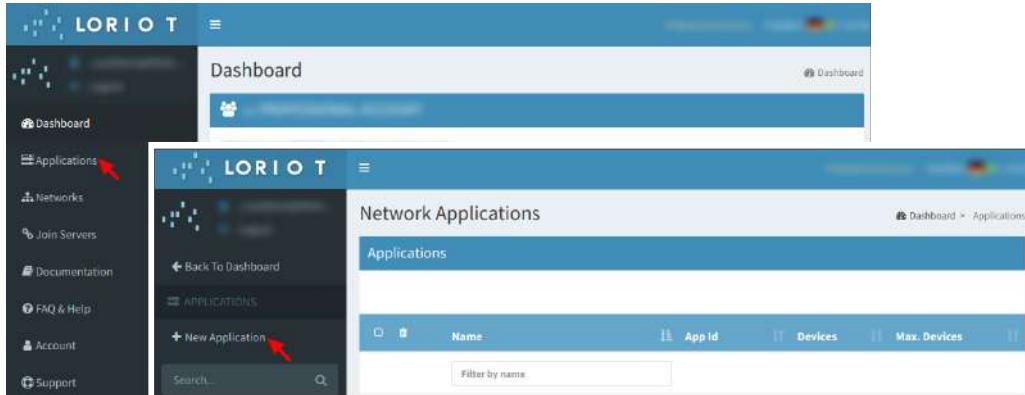
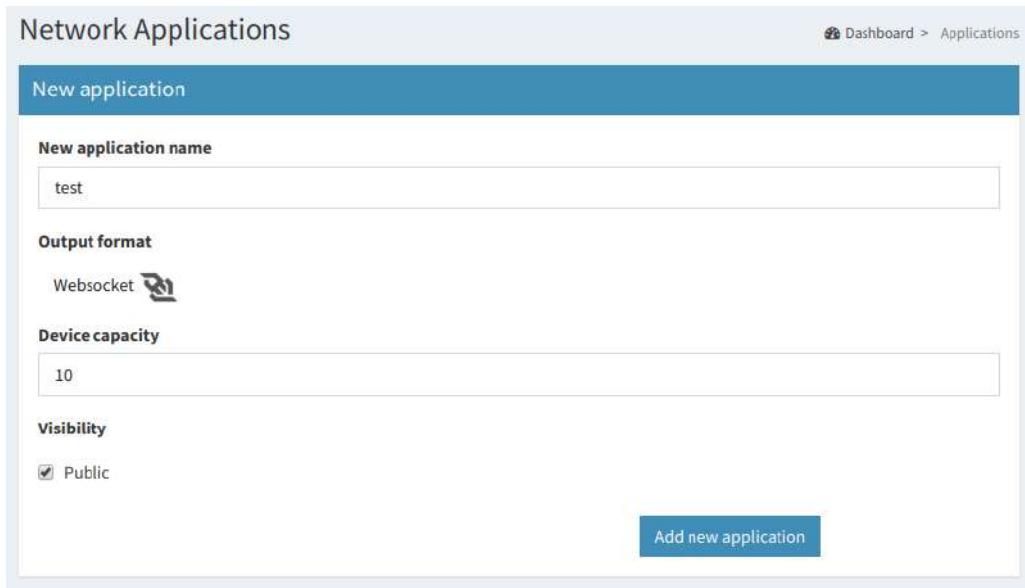


Figure 5.1.2: Creating an application

Fill the form in order to create the desired application in Loriot:

- **New application name:** Name to identify the application.
- **Output format:** “WebSocket” is selected by default and it is not possible to change it in this form. How to change it will be explained in the following step.
- **Device capacity:** Maximum number of devices to be registered in this application. The maximum value will depend on the account type you have.
- **Visibility:** This checkbox permits to set the application as “public” or “private”.



The image shows the 'New application' form. It includes fields for 'New application name' (containing 'test'), 'Output format' (set to 'WebSocket'), 'Device capacity' (set to '10'), and 'Visibility' (checkbox checked for 'Public'). A blue 'Add new application' button is at the bottom right.

Figure 5.1.3: New application form

5.1.3 Output data: Libelium Cloud URL

Once the application is created, the dashboard will be shown. Go to “Application Outputs” -> click on “Manage outputs” -> click on “Add new output”:

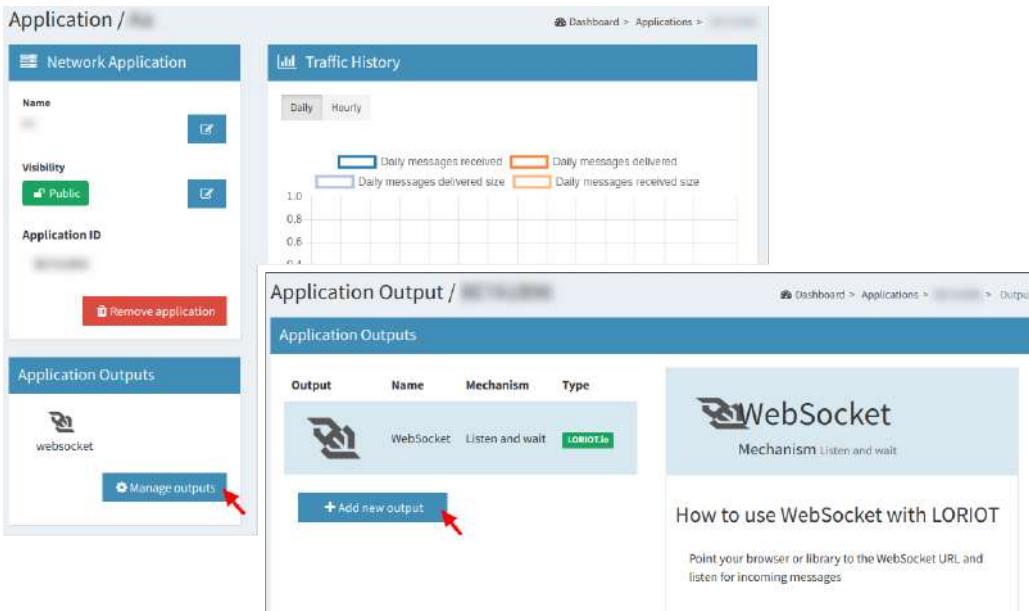


Figure 5.1.4: Create a new application output

Select “**HTTP Push**” from the list and fill the form displayed on the right side. In the “**Target URL for POSTs**” field, write the URL where Loriot must send data to (<https://api.libelium.com/cloud/parking/v2/services/loriot>). Besides, users can add an authorization header in “**Custom Authorization header value**” in order to increase the security in the communications, so the final server only accepts the information from an authorized account. Finally, click on the “**Confirm change**” button to save the information.

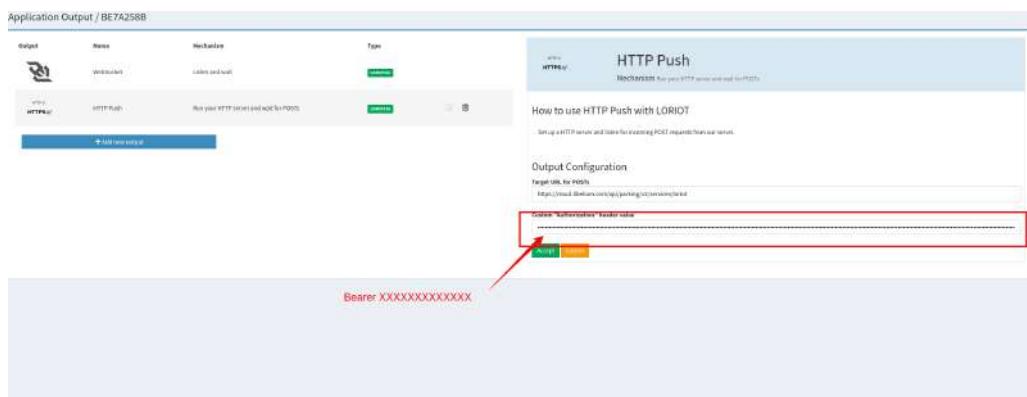


Figure 5.1.5: Loriot HTTP Push configuration

For that purpose, you can generate your own Libelium API key in the corresponding Cloud section:



This screenshot shows the 'API Keys' section of the Libelium Cloud Platform. On the left is a sidebar with links like Connectors, IAP, Alarms, Dashboard Center, Parking, Services, Tools, and API Keys (which is highlighted). The main area shows a table of API keys. One key is selected, showing its details: Name 'libelium-test', Key 'E5C1D9E0A0B9F080B703C1F9F02341B...'. A large blue modal window is open over the table, displaying the key's details and a note about its expiration. At the bottom of the modal is a 'Delete' button. The table below shows other API keys: 'libelium-test' (Key: E5C1D9E0A0B9F080B703C1F9F02341B...) and 'libelium-test2' (Key: E5C1D9E0A0B9F080B703C1F9F02341B...).

5.1.4 How to delete unused Loriot applications

A list with all application outputs will be displayed in the “Application Outputs” window. It is recommended to delete unused outputs and keep only “HTTP Push” in the list. The procedure to delete all other applications is to click on the desired ellipsis button of the application “...” and select “Delete” option. A pop-up window will ask you to confirm the operation.

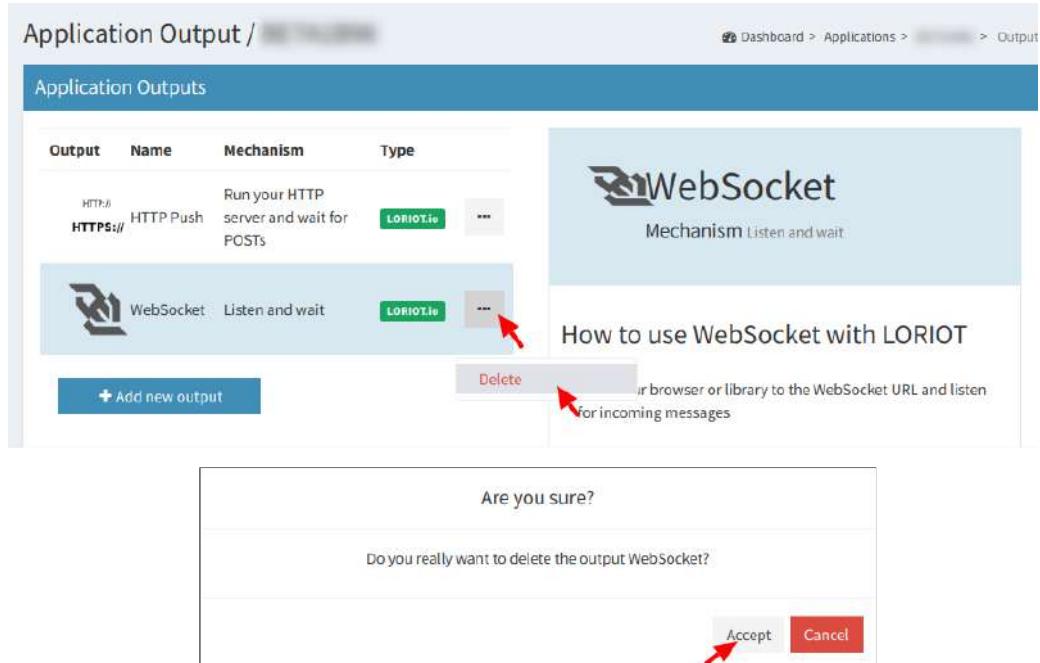


Figure 5.1.6: Delete unused application outputs

5.1.5 How to create a single device manually

Click on “Devices” left menu to show the device list. Click on “Enroll new device” button to add a new device:

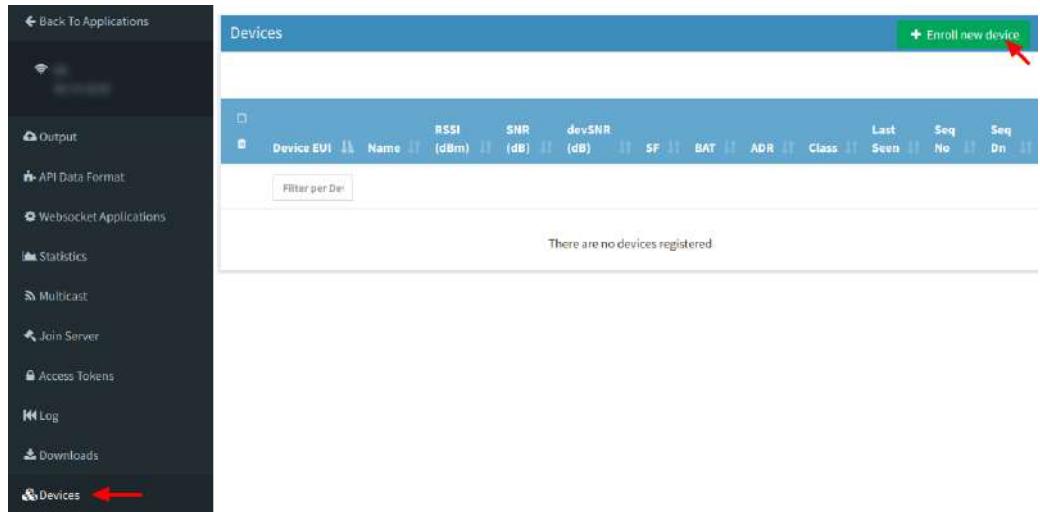


Figure 5.1.7: Enroll new device

A new form will be displayed in order to create the new device associated to the application. In this form it is possible to choose different enrolling processes based on OTAA or ABP. So, depending on the option chosen, it will be mandatory to insert different EUIs or keys. Please refer to “LoRaWAN protocol and parameters” to understand the all parameters involved in this form.

Enroll a new device

LoRaWAN Version	Enrollment process
<input type="text"/>	<input type="text"/>

Device Location

Country	<input type="text"/>
Address	<input type="text"/>
ZIP Code	<input type="text"/>
City	<input type="text"/>
Latitude	<input type="text"/>
Longitude	<input type="text"/>



About ABP enrollment v1:
Activation by personalization (ABP) is a method of delivering the network and application session key material by configuring it manually on every device.

The ABP static allocation of the device keys is less secure than OTAA.

Upon enrollment of your device, we will generate all the necessary keys and identifiers for you - DevAddr, NwkSKey and AppSKey. You can use this information to setup your end-device.

In your device, you will need to configure the following parameters:

- DevAddr - will be generated upon completing this step
- NwkSKey - will be generated upon completing this step
- AppSKey - will be generated upon completing this step

Device Details

Title	End-device address	Sequence number uplink	Sequence number downlink
<input type="text"/>	<input type="text"/> DevAddr (8)	<input type="text"/> FCntUp (Decim)	<input type="text"/> FCntDn (Decim)
EUI (optional)	Network session key		
<input type="text"/> DevEUI (16 hex digits)	<input type="text"/> NWKSKEY (32 hex digits)		
Description	Application session key		
<input type="text"/>	<input type="text"/> APPSKEY (32 hex digits)		

Create Another

Figure 5.1.8: New device form

5.1.6 Nodes batch provisioning in Loriot

Inside the Loriot application click on “**Bulk import**” and then click on “**Upload file**” to register several devices at a time. It asks for a CSV file which must be exported from the SCM.

Please refer to “[Libelium Cloud](#)” section for further information on how to export this CSV file which includes all nodes OTAA credentials needed for direct batch import.

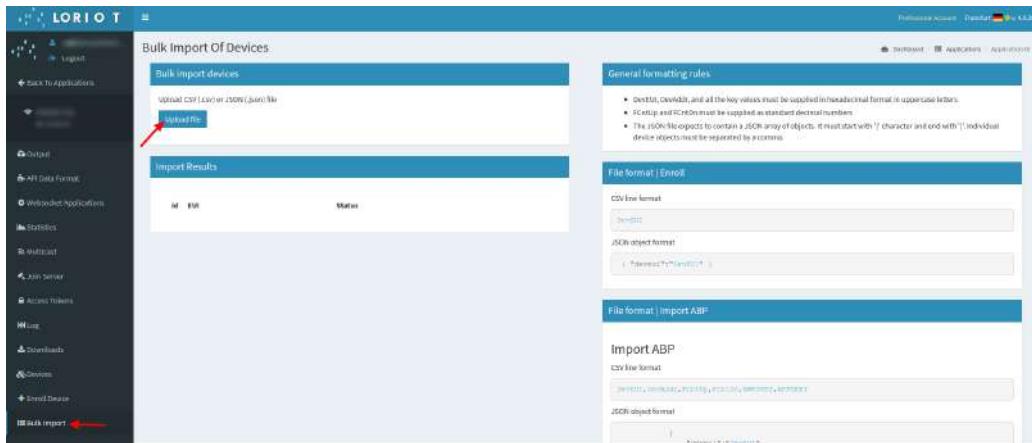


Figure 5.1.9: Loriot bulk import

The CSV file for 'N' devices must respect the next format:

```
<DevEUI_1>,<AppEUI_1>,<AppKey_1>,<Serial_1>
<DevEUI_2>,<AppEUI_2>,<AppKey_2>,<Serial_2>
<DevEUI_3>,<AppEUI_3>,<AppKey_3>,<Serial_3>
...
<DevEUI_N>,<AppEUI_N>,<AppKey_N>,<Serial_N>
```

5.2 Actility

This section explains how to route information on Actility to Libelium Cloud using the HTTPS protocol. Firstly, you must access into the Actility's [ThingPark portal](#) and log in. IN the main portal, you must go to “[ThingPark Application](#)” section and access to “[Device Manager](#)”:

The screenshot shows the ThingPark Application interface. On the left, there's a sidebar with 'Tests & Approval' (Mac Command generator, Interoperability Tool, Device Interoperability Questionnaire), 'ThingPark Application' (DX API Console, **Device Manager** (highlighted with a red box), Network Manager, Wireless Logger), 'Documentation' (Advanced Developer Guide, DX API Documentation, Gateways, FAQ, Interoperability tool user guide), 'Store' (ThingPark Market, Click & Go: Solution Store), and 'Support' (Technical Support). A red arrow points to the 'Device Manager' item. The main area has sections for 'Explorer' (two stylized human icons) and 'Partner'. To the right, there's a 'verified by Z-layers' logo with the text 'Discover the first LoRaWAN™ device qualification program which focuses on market access'. Below it, there's a list of benefits for becoming an Actility Partner: 'Get your device ThingPark Connected', 'Expose your brand directly within ThingPark', 'Sell your products on ThingPark Market', and 'Select the membership level according the marketing benefits you need'. A 'Become an Actility Partner!' button is also present. At the bottom, there's a 'News' section with three entries: '2018-11-15 Updated FAQ', '2018-06-04 New Release Notes - Explorer - Partner', and '2018-01-31 Updated ThingPark Additional Service Store - Explorer - Partner'.

Figure 5.2.1: Access to “Device Manager” menu

Actility requires an “Application Server” and an “AS routing profile” in order to establish the communication with Libelium Cloud. These 2 elements are required before starting the service the 1st time, and will be the base to

create new devices.

5.2.1 How to create a new Application Server

Starting from the main ThingPark Device Manager window, you shall create a new “Application Server” by clicking on “**Application Servers**”:



Figure 5.2.2: Device Manager menu

The first section allows you to create a new “Application Server”. Then the second section shows a list of all “Application servers” created. Click on the “**Create**” button in the first section to create a new “Application Server”:

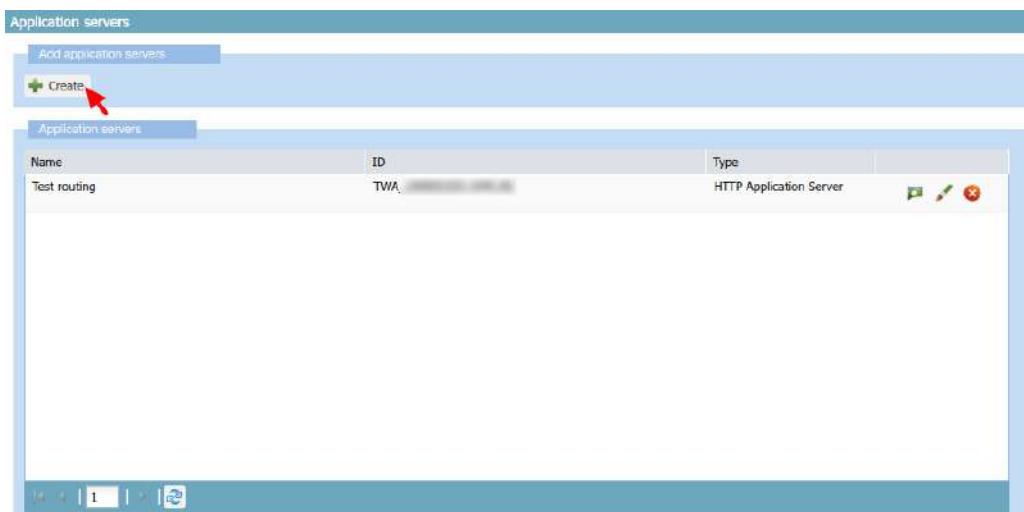


Figure 5.2.3: Application servers menu

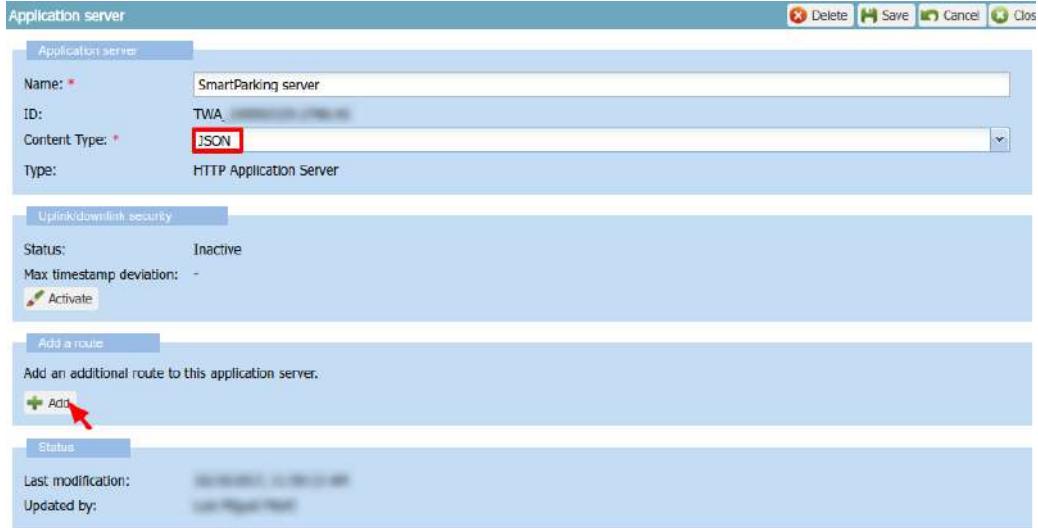
In “Name” field define your Application server name. In “Type” field, you must select “HTTP Application Server”. Finally, click on the “**Create**” button to continue:



Figure 5.2.4: Application server name

A new window appears, where the name is copied from the previous pop-up. In the “Content Type” field you

must select “**JSON**”. Then click on the “**Add**” button in “Add a route” section to create the link to the callback server installed:



The screenshot shows the 'Application server' configuration page. The 'Content Type' field is highlighted with a red box and contains the value 'JSON'. Below it, the 'Add a route' section has a red arrow pointing to the '+ Add' button.

Figure 5.2.5: Application server form

A “Route” section will be generated with a new form to be completed. Just click the “**Add**” button to proceed:



The screenshot shows the 'Route' configuration page. At the bottom of the 'Destinations' list, there is a toolbar with several icons, including a red arrow pointing to the '+ Add' button.

Figure 5.2.6: Route form

A new pop-up appears. In the “Destination” field, you must enter the URL of the server where the data is going to be sent (<https://api.libelium.com/cloud/parking/v2/services/actility>). Click on the “**Add**” button to save the information:



The screenshot shows the 'Add destination' dialog box. The 'Destination' field contains the URL 'http://myserver.com/services/actility/'. A red arrow points to the '+ Add' button at the top right of the dialog.

Figure 5.2.7: Destination form

Navigate back to the Application server form, click on “**Save**” in order to create the “Application server”.

5.2.2 How to create a new AS routing profile

The Application Server (AS) routing profile defines how a previously created “Application server” will behave. In order to create a new “AS routing profile” in the Device Manager, click on “**AS routing profiles**” button on the left sidebar menu:



Figure 5.2.8: Destination form

Then you must click on the “**Add**” button in the first section. Below, in the second section, a list with all existing “AS routing profiles” will be displayed:

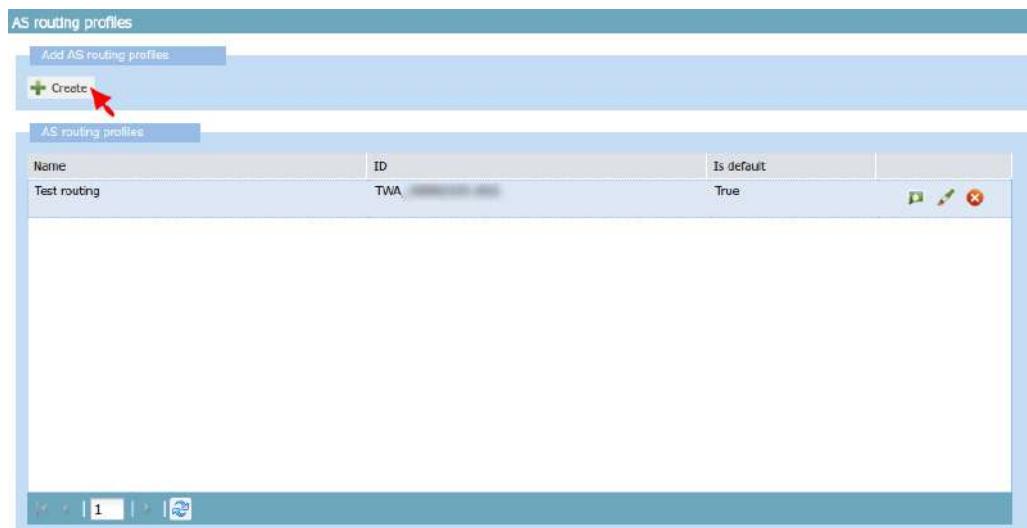


Figure 5.2.9: AS Routing profiles

In the “Name” field write the name of the AS routing profile. In the “Type” field, select LoRaWAN. Then click on the “**Create**” button to continue the process:



Figure 5.2.10: AS Routing profile name

In the new window, you can read the “AS routing profile ID” which will be needed for batch import. Besides, mark the check “Is default” and click the “**Add button**”:



Figure 5.2.11: AS Routing profile route

A new pop-up will appear with 2 parameters to be completed. “Type” is the kind of the application for our destination, “**Local application server**” must be selected. In the “Destination” drop-down field, all available Application servers will be displayed. So, the correct “Application server” previously created must be selected:

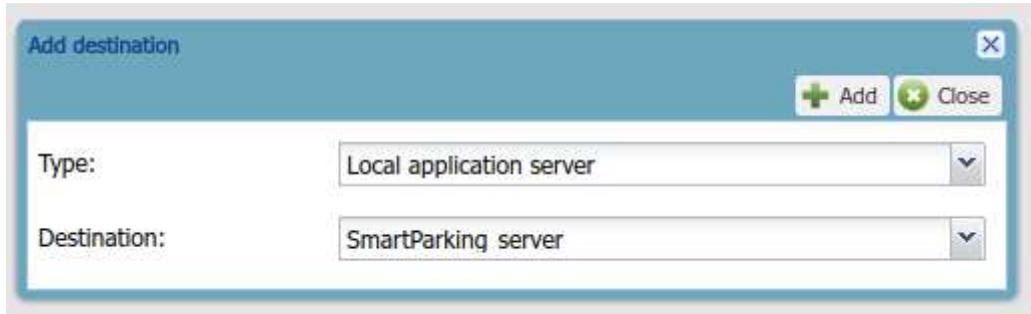


Figure 5.2.12: Add the created Application server as “destination” for the routing profile

Navigate back to the AS routing profile form, click on “**Save**” in order to create it. This process should be completed just once. From this moment, customers can add devices to the service.

5.2.3 How to create new devices manually

Once created the “Application server” and “AS routing profile”, you can create new devices. In the main ThingPark menu, click on “**Devices**” option . Then click on the “**Create**” button:



Figure 5.2.13: Create new devices

A new form will be displayed in order to define the new device’s parameters:

Administrative data

- Device name: Name to identify the device
- Marker: Icon to identify the device on the map list
- Administrative info: Relevant information of the device

- Administrative location: Location of the device
- Motion indicator: List with several options

Device identification

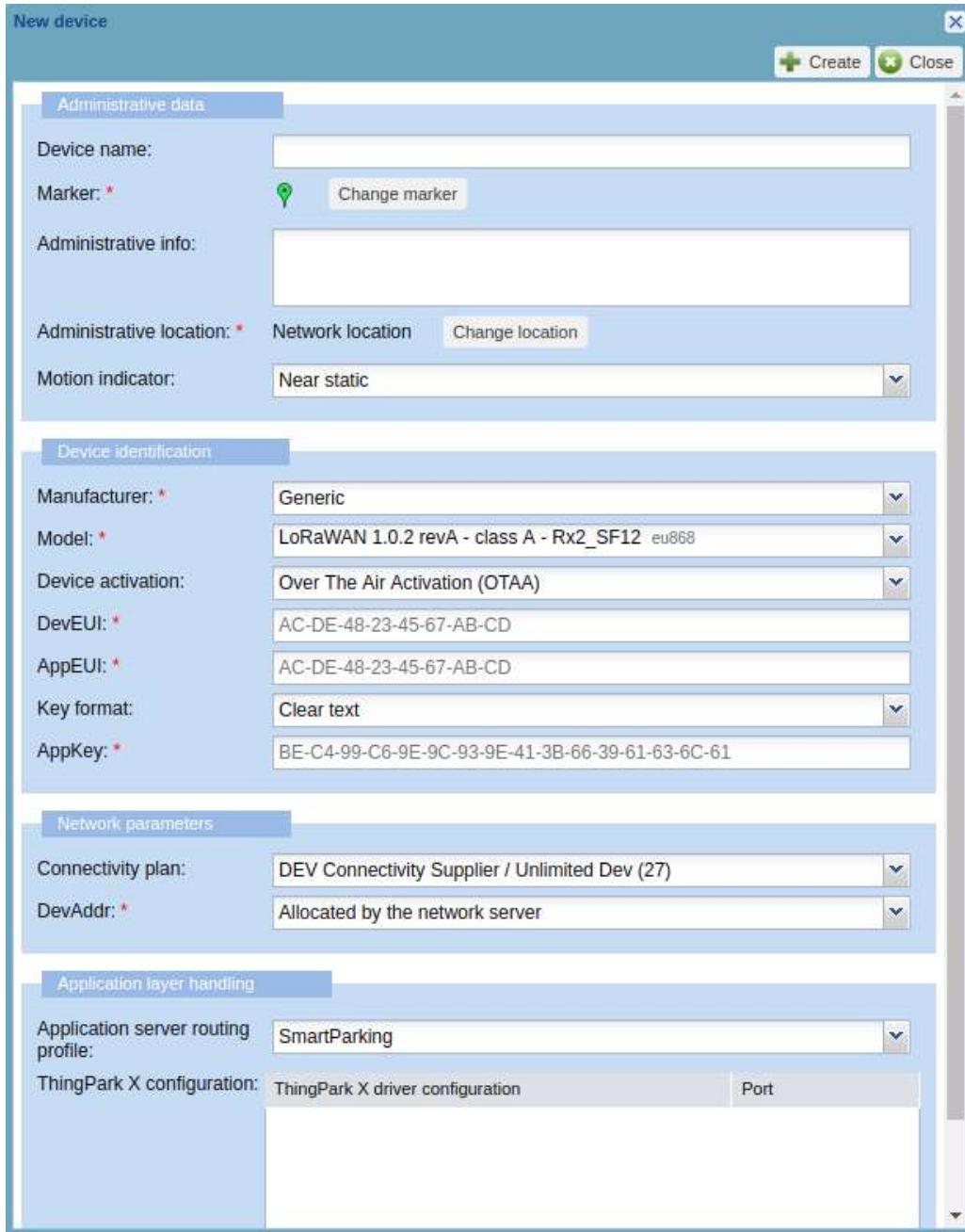
- Manufacturer: Select “Generic”.
- Model: Select the corresponding region:
 - LoRaWAN EU863-870: LORA/GenericA.1.0.2a_ESI_Rx2-SF12
 - LoRaWAN US902-928: LORA/GenericA.1.0.2a_FCC_Rx2-SF12
 - LoRaWAN IN865-867: LORA/GenericA.1revB_IN865_Rx2-SF12
 - LoRaWAN AU915-928: LORA/GenericA.1revB_AU915_Rx2-SF12
 - LoRaWAN AS923: LORA/GenericA.1_AS923_Rx2-SF10
- Device activation: Select “Over The Air Activation (OTAA)” if default parameters are used. ABP is the other option.
- DevEUI: Device EUI, globally unique IEEE EUI-64 address.
- AppEUI: Device Application identifier (mandatory for OTAA).
- Key format: Should be “Clear text” for non-encrypted key format.
- AppKey: 16-byte Application Key (mandatory for OTAA).

Network parameters

- Connectivity plan: Select a Connectivity plan on the drop-down menu.
- DevAddr: Select “Allocated by the network server”.

Application layer handling

- Application server routing profile: Select the “Application server” created before.



Administrative data

- Device name:
- Marker: *
- Administrative info:
- Administrative location: *
- Motion indicator:

Device identification

- Manufacturer: *
- Model: *
- Device activation:
- DevEUI: *
- AppEUI: *
- Key format:
- AppKey: *

Network parameters

- Connectivity plan:
- DevAddr: *

Application layer handling

- Application server routing profile:
- ThingPark X configuration:

Figure 5.2.14: Enter all device's parameters

Finally click on the “**Create**” button in order to save the information of the device.

5.2.4 Nodes batch provisioning in Actility

It is possible to register several nodes at a time using the “**Import**” button:



Figure 5.2.15: Import devices

A new window is displayed in order to import a CSV file with all devices to be imported:

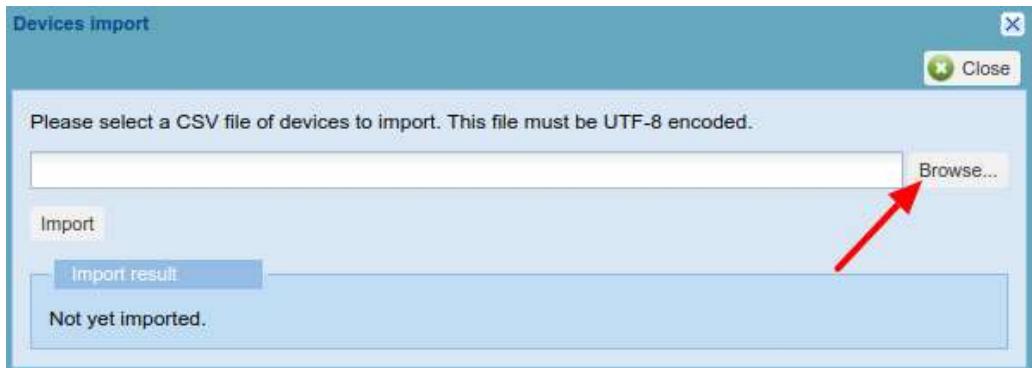


Figure 5.2.16: Import CSV file

Regarding the CSV file format, you must start from the exported CSV file from the SCM. Please refer to “Libelium Cloud management” section for further information on how to export this CSV file which includes all nodes OTAA credentials needed for direct batch import. Then, you must keep in mind that Actility needs more information to be included in that CSV file. The CSV to be imported must follow the next format (15 columns).

The CSV file for ‘N’ devices must respect the next format:

```
CREATE_OTAA,<DevEUI1>,,<DevProfile>,<AppEUI1>,<AppKey1>,,,<AS_profile_ID>,<ConnPlan>,<name>,,,,,  
CREATE_OTAA,<DevEUI2>,,<DevProfile>,<AppEUI2>,<AppKey2>,,,<AS_profile_ID>,<ConnPlan>,<name>,,,,,  
CREATE_OTAA,<DevEUI3>,,<DevProfile>,<AppEUI3>,<AppKey3>,,,<AS_profile_ID>,<ConnPlan>,<name>,,,,,  
...  
CREATE_OTAA,<DevEUI_N>,,<DevProfile>,<AppEUI_N>,<AppKey_N>,,,<AS_profile_ID>,<ConnPlan>,<name>,,,,,
```

Where:

- **CREATE_OTAA**: Should always be the same in order to import the devices using OTAA join mode.
- **<DevEUI>**: This is the Device EUI exported from Libelium SCM CSV file. Should not be changed.
- **<DevProfile>**: This field is related to the LoRaWAN region of the node. Possibilities depending on the version:
 - LoRaWAN EU863-870: LORA/GenericA.1.0.2a_ESI_Rx2-SF12
 - LoRaWAN US902-928: LORA/GenericA.1.0.2a_FCC_Rx2-SF12
 - LoRaWAN IN865-867: LORA/GenericA.1revB_IN865_Rx2-SF12
 - LoRaWAN AU915-928: LORA/GenericA.1revB_AU915_Rx2-SF12
 - LoRaWAN AS923: LORA/GenericA.1_AS923_Rx2-SF10
- **<AppEUI>**: This is the Application EUI exported from Libelium SCM CSV file. Should not be changed.
- **<AppKey>**: This is the Application Key exported from Libelium SCM CSV file. Should not be changed.
- **<AS_profile_ID>**: This is Actility’s “AS routing profile ID” which belongs to each customer’s account. It can be read from the profile when it is first created.

- <ConnPlan>: This must be set as “dev-cs/testing”.
- <Name>: Name of each device (optional).

Example for some Smart Parking EU nodes (LoRaWAN EU863-870). Let’s assume TWA_123 was the “AS routing profile ID” given by Actility for our application:

5.3 Libelium Base Station

This section explains how to route information on a Libelium Base Station to Libelium Cloud using third party Network Servers.

5.3.1 Supported LoRa Network Servers

This LoRaWAN Gateway can be configured in several ways to route LoRa data to different Network Servers.

This section is focused on the configuration of the gateway to connect to Libelium’s Cloud through the Loriot Network server.

The Manufacturer’s documentation might help customers from the very first moment to access to the device and deploy their own network [here](#).

5.3.2 Configure LoRaWAN Network Settings

In order to connect to Loriot the Semtech Packet Forwarder installed in the gateway. It can be selected and configured in the **LoRa Network -> Network Settings** section.

The Server address will be the same where the Network and Application of the customer’s account is created.

Up and down port must be set to **1780**.

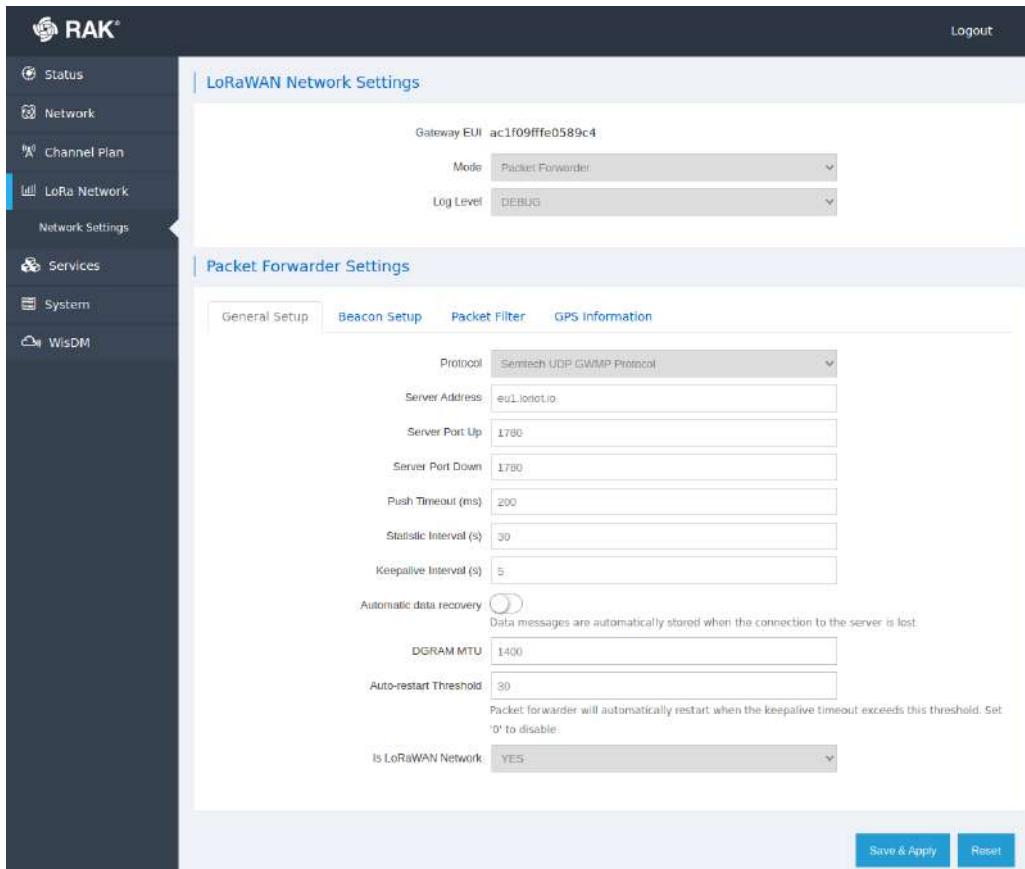


Figure 5.3.1: LoRaWAN Network Settings

5.3.3 Register the gateway in Loriot

Adding a new gateway in Loriot provides several models, amongst which the user must chose. Although this gateway model is not among them, the Semtech Packet Forwarder is available for the user to configure with this gateway:

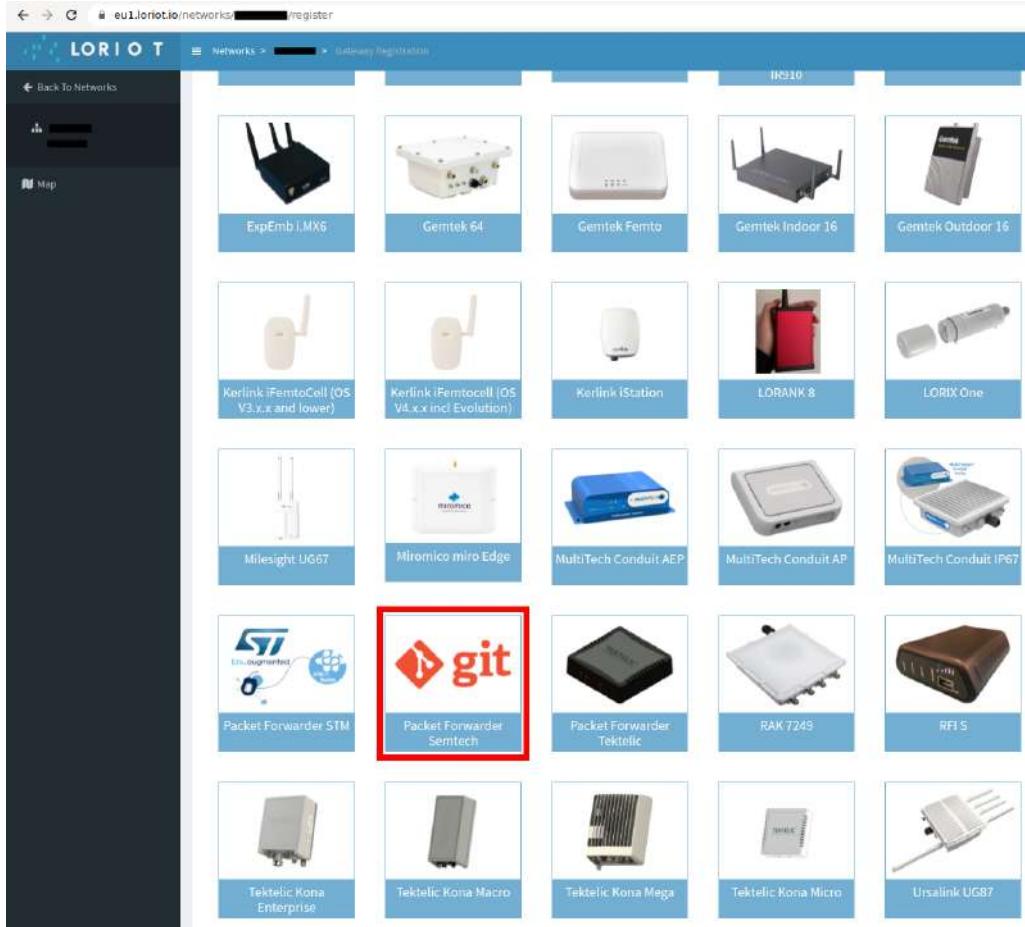


Figure 5.3.2: Loriot Gateway Registration

To connect the gateway to Loriot, the physical MAC address and Gateway EUI must be set in the register process.

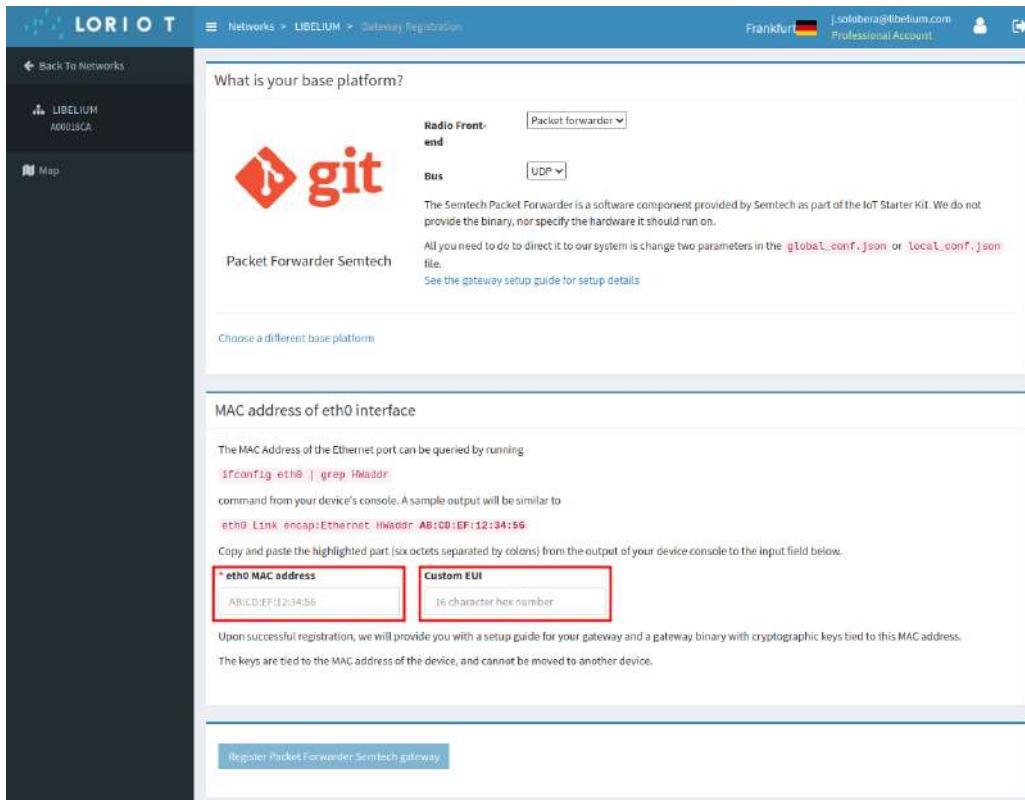


Figure 5.3.3: Loriot Gateway Registration

The device MAC address can be found in the **Network -> WAN Interface** section.

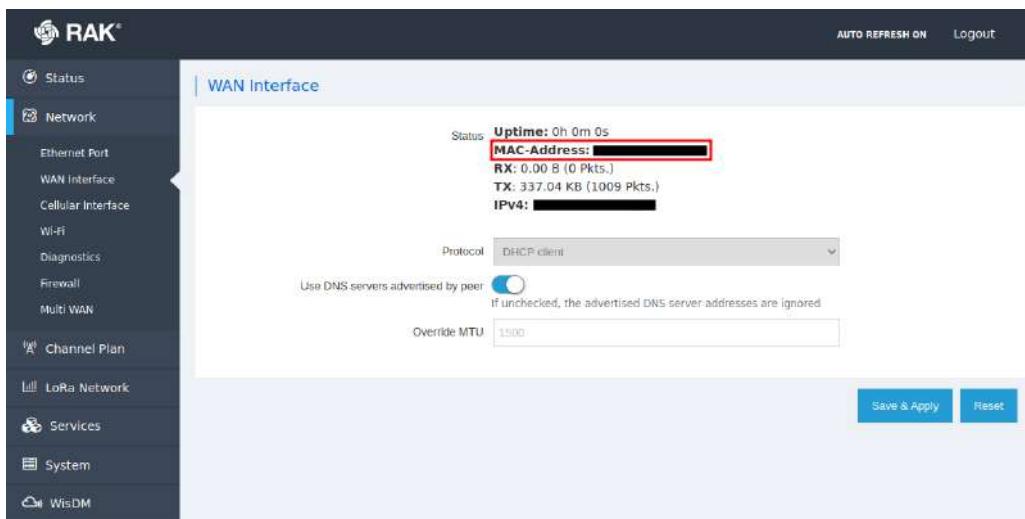


Figure 5.3.4: Loriot Gateway Registration

The Gateway EUI can be found in the **LoRa Network -> Network Settings** section.

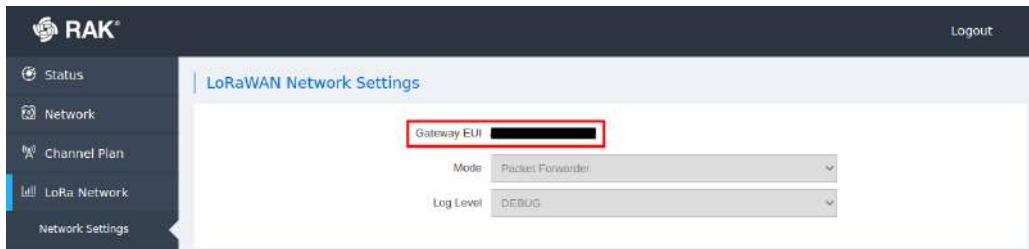


Figure 5.3.5: Loriot Gateway Registration

After registration, frequency plan can be configured in the gateway section.

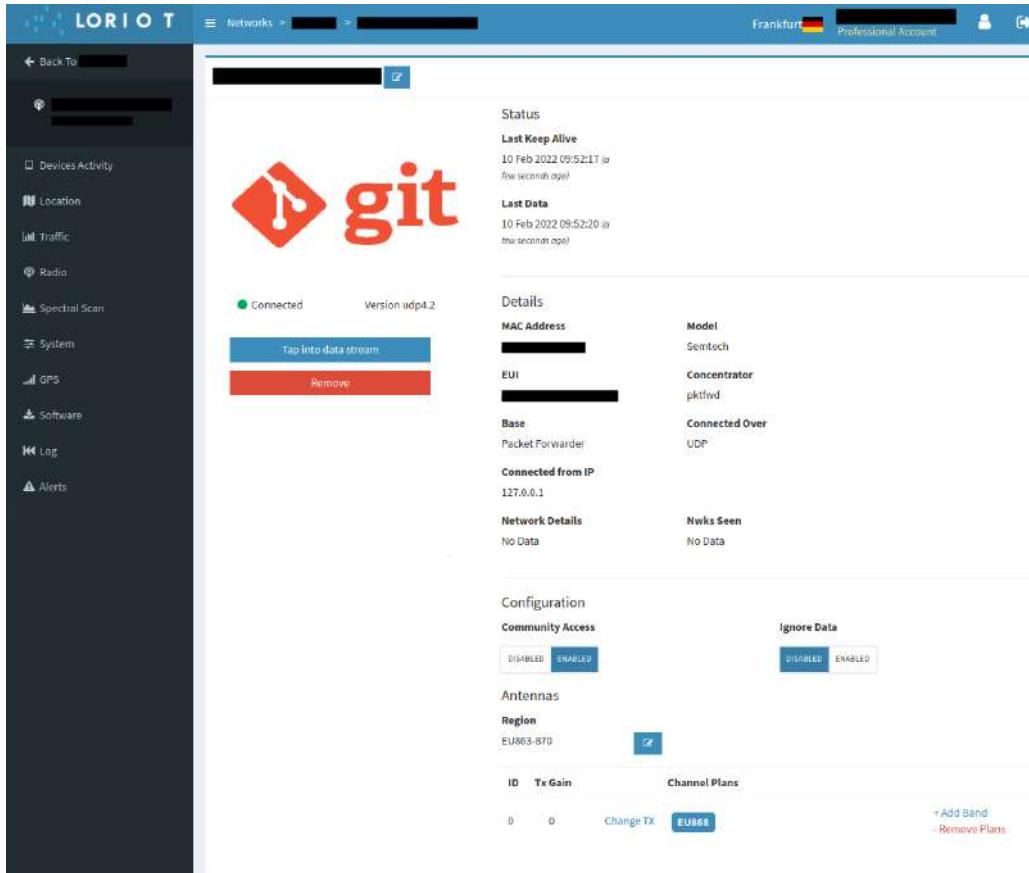


Figure 5.3.6: Loriot Gateway Registration

6 Cloud system

Cloud system options:

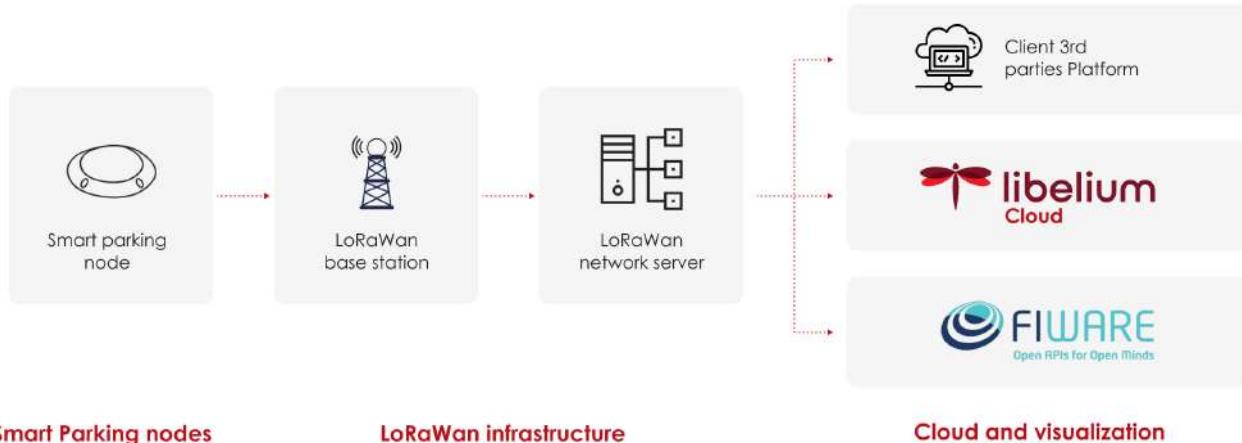


Figure 6.0.1: Smart Parking architecture

6.1 Libelium Cloud

Libelium Cloud features:

- SaaS solution
- Store, visualize and analyze the data received from your Air Quality Station devices.
- Remotely manage all your devices.
- Get LoRaWAN encryption keys.
- Connectors to send data to Clouds in the market: Amazon Web Services, Microsoft Azure,...



Figure 6.1.1: Libelium Cloud

6.2 FIWARE

FIWARE features:

- On-premise solution
- ChirpStack as LoRaWAN Network Server
- Visualization provided

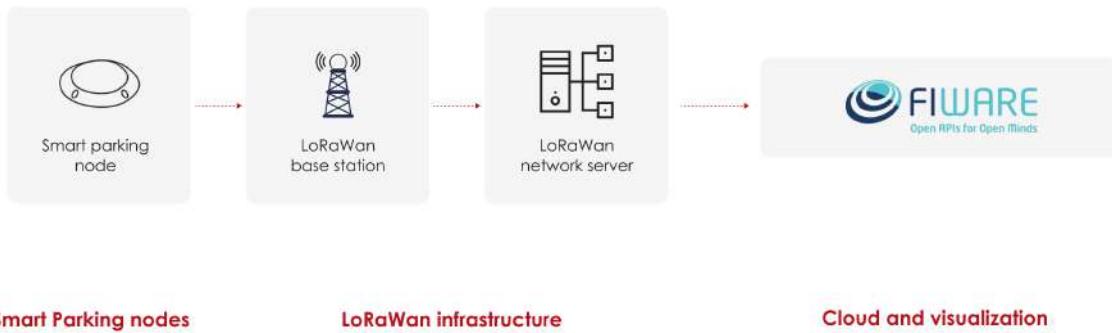


Figure 6.2.1: FIWARE as Cloud platform

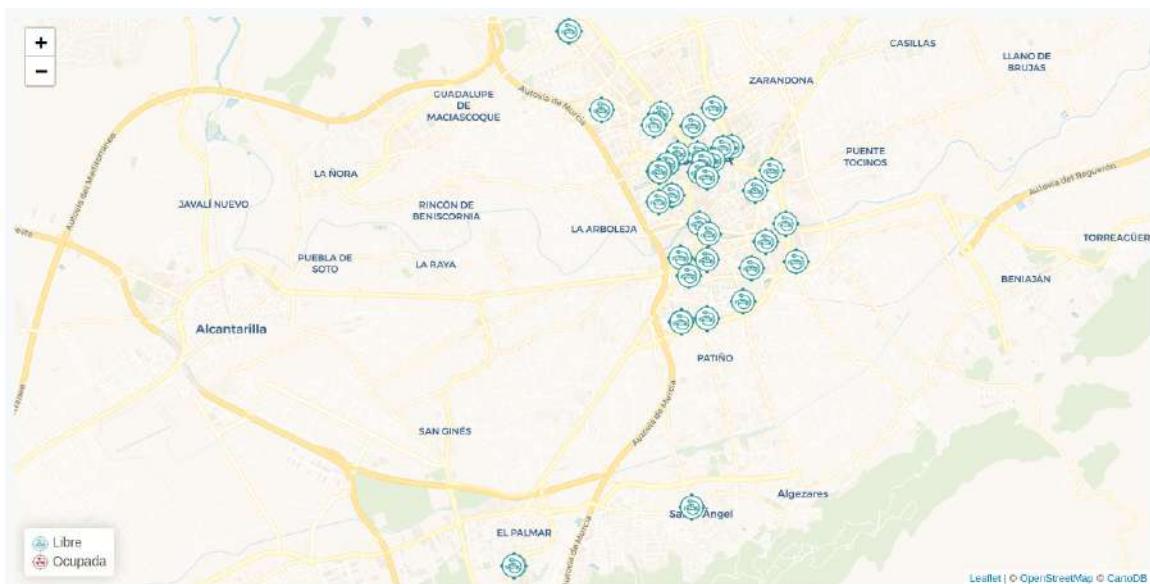


Figure 6.2.2: Visualization provided by Libelium in FIWARE solutions

6.3 Client third party platform

Client third party platform features:

- On-premise solution
- Any LoRaWAN Network Server managed by the user
- Frames decoding documentation is provided by Libelium

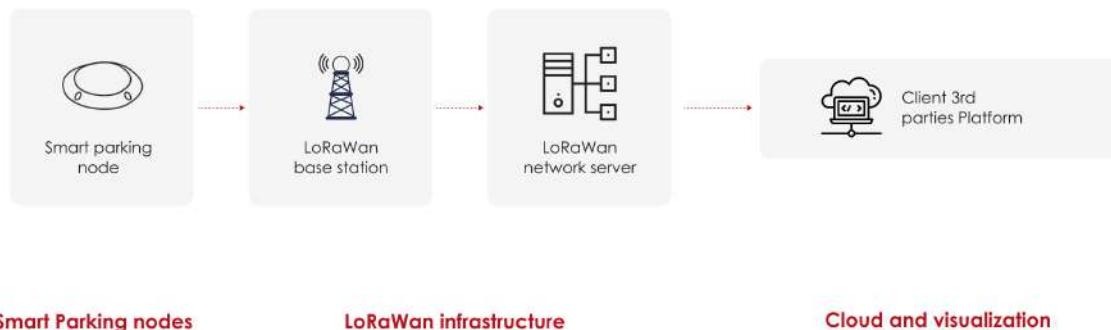


Figure 6.3.1: Client third party platform

Warning: Database managementent, Visualization and Remote Configuration must be developed by the Client

7 Deployment and installation

7.1 Step-by-step guideline

Once you receive the Smart Parking batch, the steps involved in the deployment of the network are:

1. **Nodes provisioning:** Once the client owns a LoRaWAN Network Server license, it is mandatory to register the nodes with the configured identifier and keys for each node. The client must decide whether they use the factory default LoRaWAN unique identifier and random private keys provided by Libelium or they prefer to configure their own identifier and keys. You must keep in mind that every node is provided “ready to install” with factory default identifier and keys. If client-configured identifier and keys are desired, then each node will have to be configured separately using the Smart Devices App. This 2nd option increases the provisioning time. So Libelium recommends using the default IDs and keys. If factory default keys are used, then a CSV file exported from Libelium Cloud can be used to ease the bulk import into the LoRaWAN Network Server. Find the factory default IDs/keys in the [Node keys](#) tool section.
Please refer to the “[Smart Devices App](#)” chapter for further information about the Smart Devices App.
2. **Libelium Cloud:** It is used to receive, store and exploit data. The user can also perform remote configuration of nodes and forward data to a 3rd party cloud. The LoRaWAN Network Server must be configured to properly forward all packets to Libelium Cloud.
3. **Nodes installation:** Each node must be placed on the proper parking slot and then follow the “magnet start-up” protocol explained in the “[Magnet start-up process](#)” section.



Figure 7.1.1: Smart Parking network architecture

7.2 How to place the nodes

The correct installation spot is the center of the parking slot to ensure the best detection. It is possible to install the nodes on different parking slot configurations:

- Parallel
- Perpendicular
- Angled

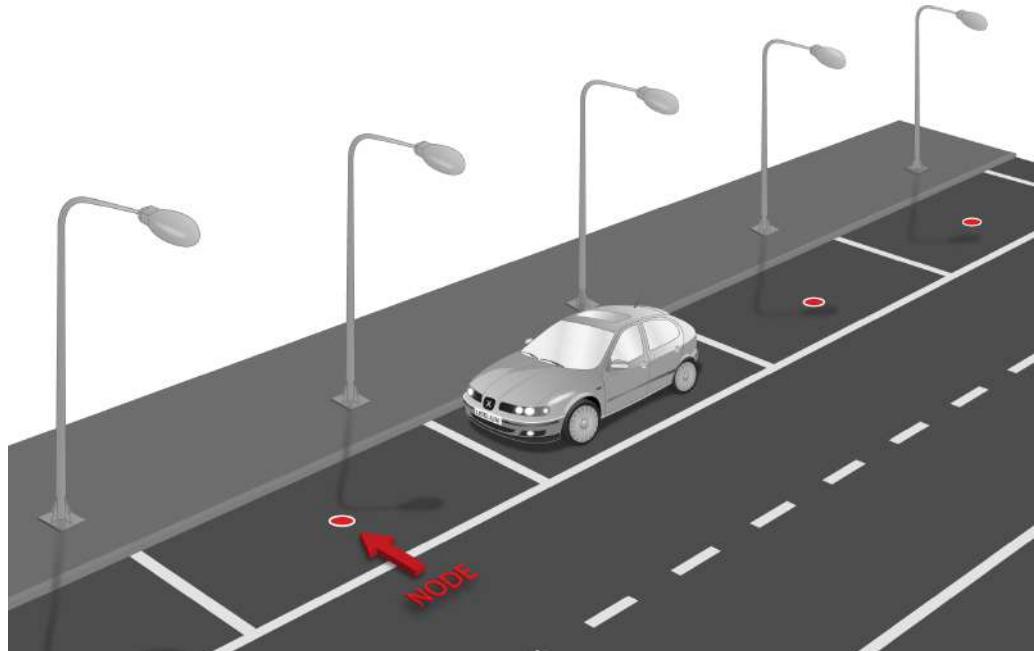


Figure 7.2.1: Parallel parking slots

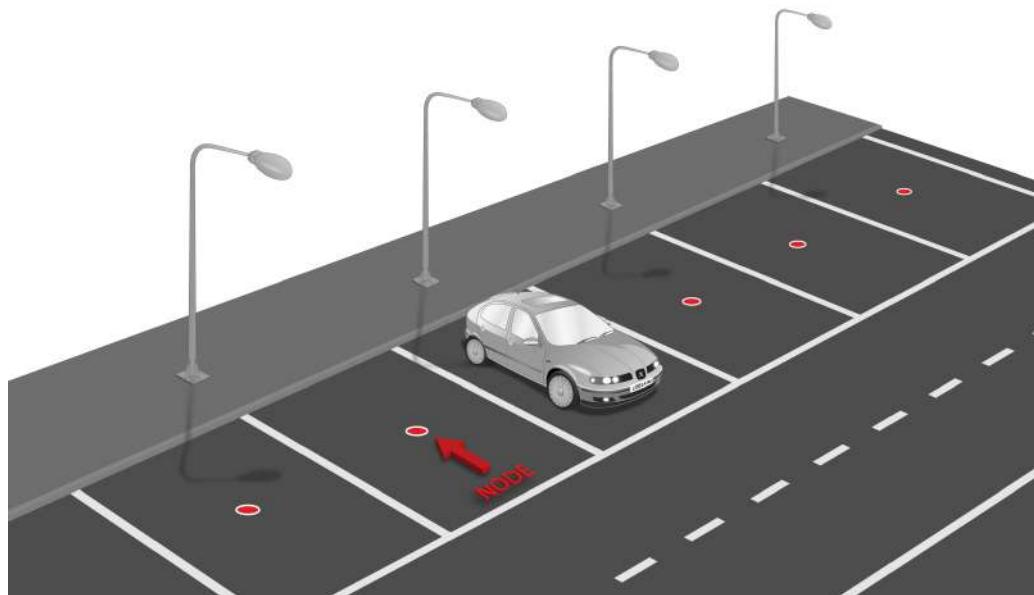


Figure 7.2.2: Perpendicular parkings lots

It is important to keep in mind that parking slots must be delimited by lines so the node is placed in the center of the parking area. Placing the nodes with no line definitions may lead into bad behaviour.

7.3 Node installation

The user can choose among different types of installation for the node. This table summarizes pros and cons:

	On-surface installation	Semi-underground installation
Type of enclosure	Vaulted	Vaulted
Presence of node over the ground	Full node (40.25 mm)	Part of node (6 mm)
Rain immunity	Yes	Yes
Puddle immunity	Yes	Yes
Vandalism/robbery immunity	Medium	High
Snowplow immunity	No	Possible
Installation process,	Fast and easy	Special tools needed
Tools needed	Normal drill	Industrial big crown drill. Epoxy.
Can be dismantled for maintenance	Yes	No

Note: Since 2022, the “Underground” installation type is no longer supported.

7.3.1 On-surface node installation

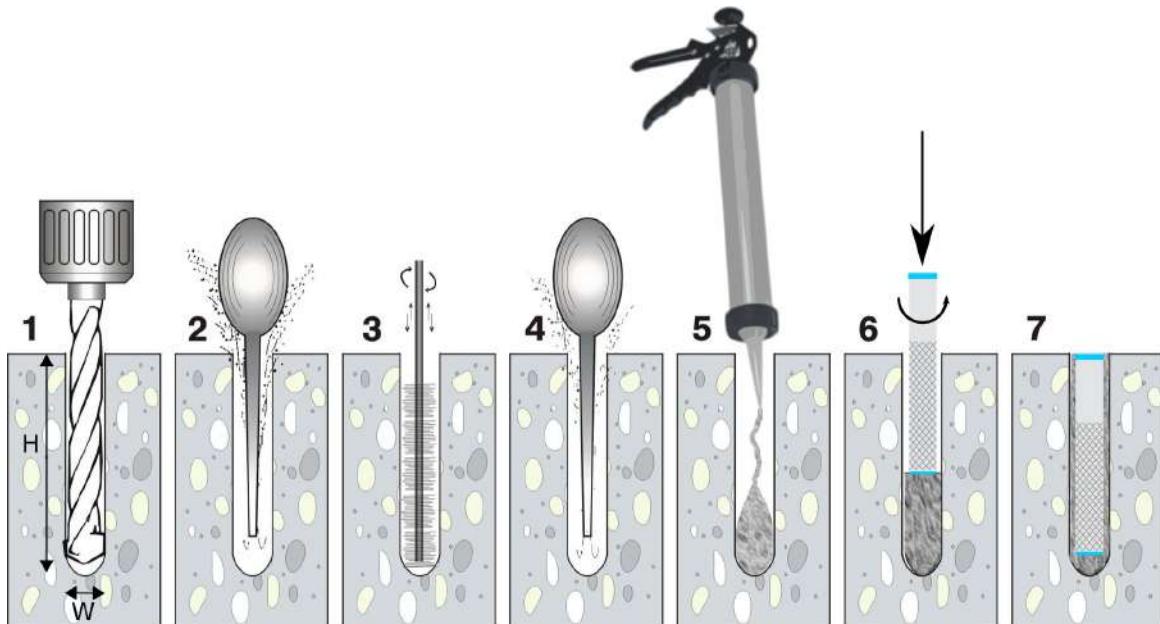


Figure 7.3.1: Step by step chemical fixing and anchor installation

Firstly, mark 4 holes in the asphalt. Select an area as flat and regular as possible, avoid irregularities on the terrain. You should place the enclosure in the final location and use the 4 holes as a reference to drill 4 little marks on the ground. You can also draw 4 dots with ink.



Figure 7.3.2: Marking the holes for the node

Then continue with the chemical fixing installation step by step as described above. Also, in the next video you can see how the installation is done [chemical fixing installation](#).

Step 1: Drill the holes. The drill diameter must be $W=14$ mm minimum. Try to drill as vertical as possible to enable the best enclosure installation. The length of the hole must be about $H=85$ mm.



Step 2, 3 and 4: Blow out dust and loose materials. Remove all the dust and little rocks inside the 4 holes, created during the drilling operation. This is important to allow the anchors go all the way down. You can clean each hole mechanically and then use a bottle of spray duster (high-pressure air bottle). Make sure that the real depth of the hole is enough.



Step 5: Inject the chemical fixing. The chemical fixing shall be injected into the 4 holes carefully. You must keep in mind that this chemical adhesive must fill the complementary space the anchor leaves in the hole. So the whole hole does not have to be fully filled with adhesive because there is no space left for the anchor. The chemical adhesive quantity to be injected will depend on the dimensions of the holes.



Step 6: Insert the anchors. Once the adhesive is injected, the anchor must be carefully inserted into the hole. Rotating the anchor by hand while inserting it is a good practice. Therefore, the adhesive fills and completes all the empty space left by the anchor in the hole. Once the anchor is correctly inserted, some adhesive might exceed from the hole. This residuary adhesive must be removed from the installation so the are no extra adhesive and the anchor installation is clean and smooth.

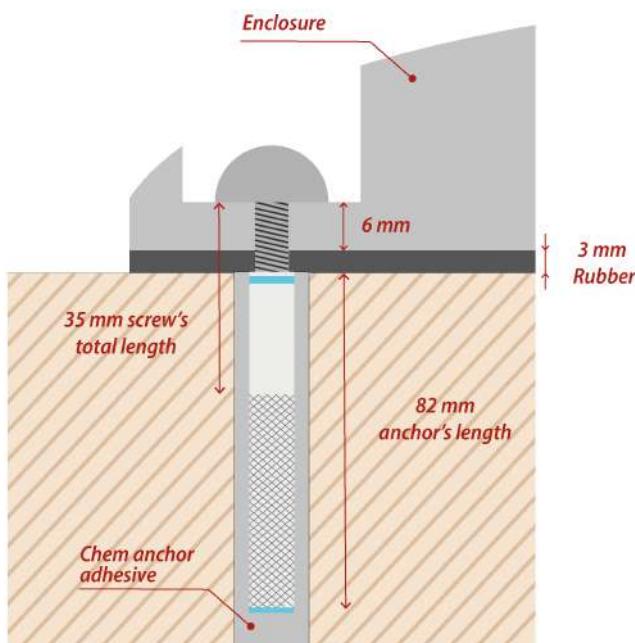


Step 7: Finish anchors installation. The anchors have an internal thread to screw the screws. Inserting the anchors with the screws partially inserted might be a good practice in order to place the anchor correctly aligned within the hole (that means you can use the screw as a tool if it is partially inserted inside the anchor). Also, if the screw is inside the anchor, avoids that the adhesive accidentally gets inside the anchor. After cleaning the remaining adhesive from the hole, the user must wait some time until the chemical resin is solid and stable. After this period of time, the screws can be removed from the anchors and the installation is finished.



Step 8: Place the node. Place the black rubber circle on the ground. To enable the correct screwing of the screws inside the anchors, make sure that there is no dust in the internal thread of the anchor. Install the node in its final position and screw the 4 special (anti-vandalism) screws provided. Anti-vandalism screws are recommended to avoid problems: anyone could unscrew a node if fixed with standard screws.





7.3.2 Semi-underground node installation

This is a possible installation in order to provide vandalism immunity and also rain/puddle immunity. So the node partially inserted in the ground and the vaulted enclosure minimizes the water issues.

Regarding the installation process, the next steps explain how to correctly install the device:

Step 1: Drill the hole. Use a hole saw or other dedicated tool to drill a hole into the pavement bigger enough for the enclosure (minimum diameter 202 mm). Try to perforate it deep enough to insert the Smart Parking node completely without rising over the surface, be sure that the enclosure remains under the pavement line approximately 10 mm.

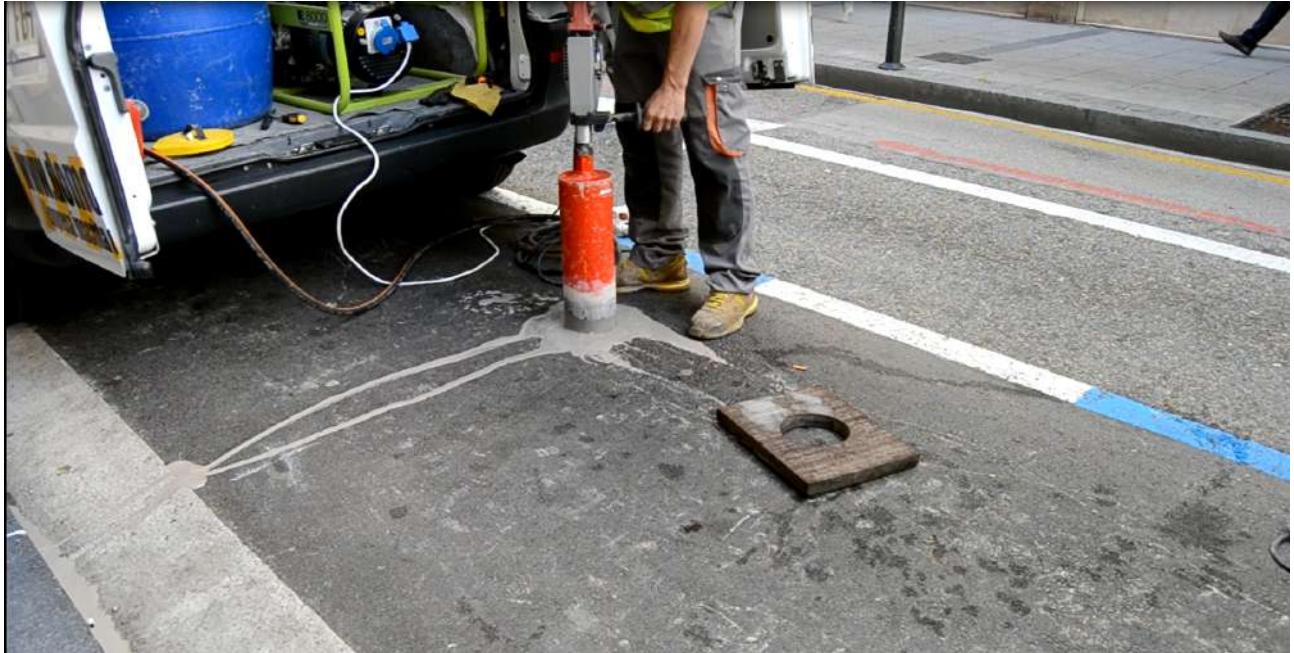


Figure 7.3.3: Making a hole in the pavement

Step 2: Place the node into the pavement hole. Below the device, a layer of cement must be spread to elevate the device to the correct horizontal position independently of the depth of the hole. The diameter of the hole must be at least 202 mm.

Step 3: Fill the hole. Finally, the node needs to be fixed to the pavement using Epoxy resin (commonly used for filling road fissures). This resin should fill all the space between enclosure and pavement. Also, it should completely cover the top of the enclosure ensuring protection against water, bad environmental conditions and

vandalism. The Epoxy resin tested by Libelium provides a curing time around 6-12 hours at 20 °C and RH 50%. So the parking installation must not be used prior this curing time.



In this installation, it is crucial that the upper side of the enclosure is not covered with Epoxy or other material. Only the side slides can be covered, the center of the node must be clean to allow the radar signal work properly.

In the node placement step, the vaulted enclosure must exceed the horizontal pavement layer by 6-7 mm approximately. The next figure shows how the node is placed:

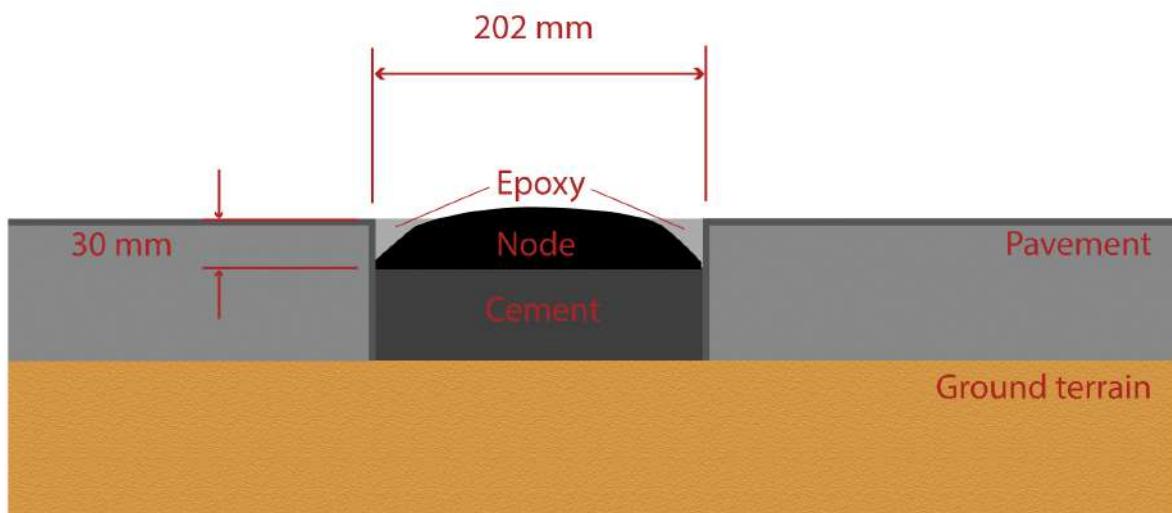


Figure 7.3.4: Semi-underground node installation

Step 4: Start the node using the magnet. Proceed with the “Magnet start-up” process in order to initialize the node.

7.4 Node start-up

After the node is installed, you must follow the “Magnet start-up” steps explained in the “Magnet start-up process” section. This process is based on 3 consecutive magnet resets waiting at least one second between each reset. In the future need of resetting the node manually, just a single magnet reset will be needed.

Once the node has been started, it will begin to run the firmware step-by-step as explained in the “How the node works” section.

In the next video you can see how the “magnet start-up” is performed: [magnet start-up](#).



Figure 7.4.1: Using the magnet to start the node

7.5 Working example

The next diagram explains how the node program works when the node is installed and started when the parking slot is free. On the left column you can see the parking slot status during the execution. On the right side you can see the frame types that are sent to Libelium Cloud depending on parking slot status changes, elapsed time and user configuration changes.

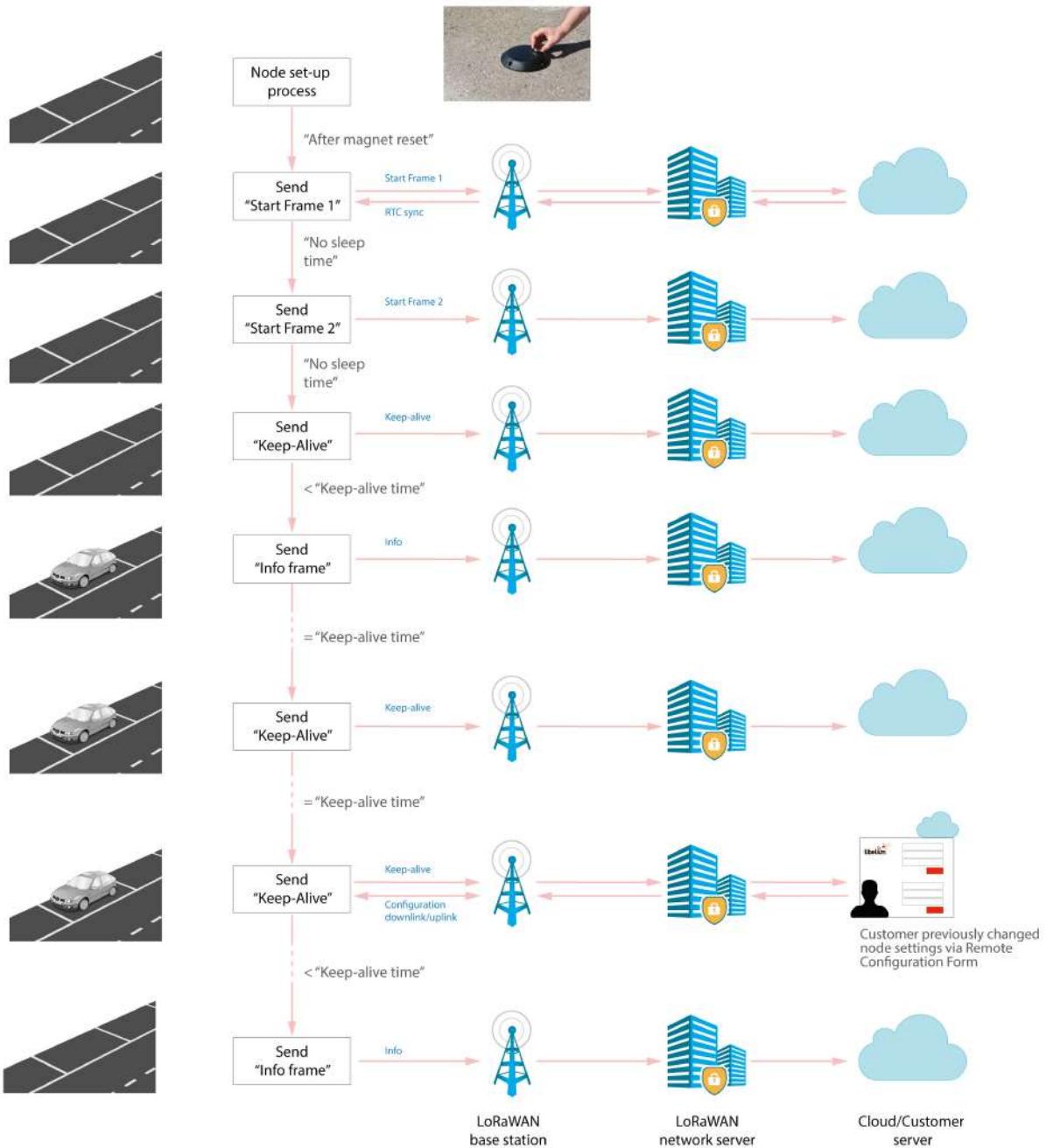


Figure 7.5.1: Smart Parking node working example

7.6 How to replace the battery

Battery replacement procedure

8 Certifications

8.1 CE (European Union)

Go to [CE Declaration of Conformity](#)

8.2 FCC (United States)

“Smart Parking v2 US” complies with Title 47 Part 15 subpart B of the FCC rules and regulations for Radio Frequency Devices – Unintentional Radiators (2019). This device contains the following transmitter modules:

- FCC ID: T9JRN2903
- FCC ID: 2AQ6KA1

8.3 UKCA (UK)

Go to [UKCA Declaration of Conformity](#)

8.4 IP68 (EN 60529)

“Smart Parking v2” was tested according to the standards UNE-EN 60529:2018 + /A1:2018 + /A2:2018 (EN 60529:1991 + Erratum:1993 + /A1:2000 + /A2:2013).

Protection against solid foreign objects

The node was introduced inside an IP6X dust chamber for 8 hours, with talcum powder 2 kg/m and an internal 20 mbar pressure depression. After tests, no traces of dust were found inside the enclosure, proving an IP6X degree of protection. IP6X is the **maximum** rating for protection against solid foreign objects.

Protection against ingress of water

The node was introduced inside an immersion tank for 30 minutes. This test was performed with the lowest point of the enclosure at 1.2 m below water surface. After tests, no water traces observed inside the enclosure, proving an IPX8 degree of protection. IPX8 is the **maximum** rating for protection against ingress of water.

8.5 IK10 (EN 50102)

“Smart Parking v2” was tested according to the standards UNE-EN 50102:1996 + A1:1999 + Corr:2002 + A1 CORR:2002 (EN 62262:2002).

The node was submitted to 20 J impacts in several points of the enclosure (the equivalent to the impact of a 5 kg mass dropped from 400 mm above the impacted surface). After tests, no cracks nor holes were observed on the tested samples, proving an IK10 degree of protection. IK10 is the **maximum** rating for protection against external mechanical impacts.

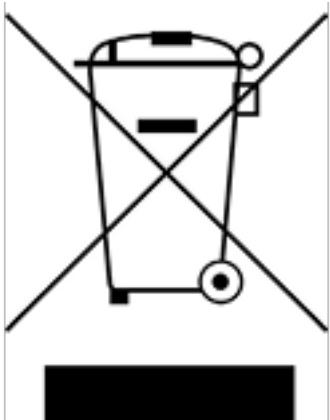
If you want to know more about certifications please refer [here](#).

9 Maintenance

- In this section, the term “Smart Parking” encompasses both the device itself as well as its accessories.
- Although Smart Parking is a highly resistant product, please handle with care in order to enjoy a longer useful life.
- Handle Smart Parking with care, do not allow it to drop or move roughly.
- Avoid placing the devices in areas reaching high temperatures that could damage the electronic components.
- Avoid aggressive environments (corrosive gases, animals, excessive/condensing humidity or atmospheres with salt suspended in the air).
- The antenna and battery connect on gently to their connectors, do not force upon installing or you could damage the connector.
- Plug the antenna or battery only in their corresponding connectors.
- Do not use any type of paint on the device, it could affect the operation of closing mechanisms.
- For cleaning, use a damp cloth, no aggressive chemical products.

10 Disposal and recycling

- When Smart Parking reaches the end of its useful life you can contact Libelium Sales department in order to ask for replacement.
- In case of not desiring to be used anymore it must be taken to a recycling point for electronic equipment.
- The equipment should be disposed of separately from solid urban waste, please dispose of correctly.
- Your distributor will advise you on the most appropriate and environmentally-friendly way of disposing of the product and its packing.



11 Safety Guides

11.1 Smart Parking Chemical Fixing Cartridge

Material Safety Data Sheet as per regulation (EC) 1907/2006 Commercial Product Name: FIS P 300 T Revision date: 30.07.2013		fischer INNOVATIVE SOLUTIONS
Version: 3.2/en		Print date: 30.07.2013
<u>SECTION 1: Identification of the substance/mixture and of the company/undertaking</u>		
1.1 Product identifier Commercial Product Name FIS P 300 T		
1.2 Relevant identified uses of the substance or mixture and uses advised against Relevant identified uses composite mortar Recommended restrictions None under normal processing. Observe technical data sheet.		
1.3 Details of the supplier of the safety data sheet Company designation fischerwerke GmbH & Co. KG Weinhalde 14-18 D-72178 Waldachtal Telephone: +49(0)7443 12-0 FAX: +49(0)7443 12-4222 Email: info-sdb@fischer.de		
Marketer Great Britain: Mrs Mirka Valovicova, fischer Fixing (UK) Ltd, Hethercroft Road, Wallingford, Oxfordshire, OX10 9AT, Tel. 01491 827 920, Fax 01491 827 950		
1.4 Emergency telephone number Emergency telephone number +49(0)6132-84463 (24h)		
<u>SECTION 2: Hazards identification</u>		
2.1 Classification of the substance or mixture Classification according to Regulation (EC) No. 1272/2008 Skin Irrit. 2; H315 Eye Dam. 1; H318 Skin Sens. 1; H317 Classification according to Directive 67/548/EEC / 1999/45/EEC R43 Xi; R41		
2.2 Label elements Hazard pictogram  GHS05		
Signal word Danger  GHS07		

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

Hazardous component(s) to be indicated on label portland cement, 2-hydroxypropyl methacrylate, dibenzoyl peroxide

H-statement(s) H315: Causes skin irritation.
 H317: May cause an allergic skin reaction.
 H318: Causes serious eye damage.

P-statement(s) P101: If medical advice is needed, have product container or label at hand.
 P102: Keep out of reach of children.
 P280: Wear protective gloves/protective clothing/eye protection/face protection.
 P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
 P310: Immediately call a POISON CENTER or doctor/physician.

2.3 Other hazards

Health hazard None known.

Particular information pertaining specific risk for human / environment None known.

Indication of danger None known.

Hazard precautions None known.

SECTION 3: Composition/information on ingredients

Hazardous ingredients

Ingredient		Classification (EEC) No 67/548	Concentration
		Classification (EC) 1272/2008	
Quartz (SiO ₂)	CAS No.: 14808-60-7 EC-No.: 238-878-4		25.0 - 50.0 % by weight
portland cement	CAS No.: 65997-15-2 EC-No.: 266-043-4	Xi; R37/38-41 Skin Irrit. 2; H315 Eye Dam. 1; H318 Skin STOT SE 3; H335	10.0 - 25.0 % by weight
2-hydroxypropyl methacrylate	CAS No.: 27813-02-1 EC-No.: 248-666-3 Index-No.: 607-125-00-5	R43 Xi; R36 Eye Irrit. 2; H319 Skin Sens. 1; H317	< 2.5 % by weight
ethanediol, ethylene glycol	CAS No.: 107-21-1 EC-No.: 203-473-3 Index-No.: 603-027-00-1 REACH No.: 01-2119456816-28-xxxx, 02-2119752517-33-xxxx	Xn; R22 Acute Tox. 4; H302 STOT RE 2; H373	< 2.5 % by weight
dibenzoyl peroxide	CAS No.: 94-36-0 EC-No.: 202-327-6 Index-No.: 617-008-00-0 REACH No.: 01-2119511472-50-xxxx	E; R3 O; R7 Xi; R36 R43 Org. Perox. B; H241 Eye Irrit. 2; H319 Skin Sens. 1; H317	< 2.5 % by weight
2-methoxy-1-methylethyl acetate	CAS No.: 108-65-6 EC-No.: 203-603-9 Index-No.: 607-195-00-7	R10 Flam. Liq. 3; H226	< 2.5 % by weight

Material Safety Data Sheet as per regulation (EC)
1907/2006



Commercial Product Name: FIS P 300 T
Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice	If symptoms persist, call a physician. Remove/Take off immediately all contaminated clothing.
If inhaled	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
In case of skin contact	IF ON SKIN: Gently wash with plenty of soap and water.
In case of eye contact	In case of eye contact, remove contact lens and rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
If swallowed	If swallowed, seek medical advice immediately and show this container or label. Clean mouth with water and drink afterwards plenty of water. Drink 1 or 2 glasses of water. Do NOT induce vomiting.

4.2 Most important symptoms and effects, both acute and delayed

Symptoms	None known.
----------	-------------

4.3 Indication of any immediate medical attention and special treatment needed

Immediate medical attention	No data available
Special medical treatment	No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media	Carbon dioxide (CO ₂) Dry powder Foam Water spray jet
------------------------------	--

Extinguishing media which must not be used for safety reasons	High volume water jet
---	-----------------------

5.2 Special hazards arising from the substance or mixture

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases	Heating or fire can release toxic gas.
---	--

5.3 Advice for firefighters

Special protective equipment for firefighting	In the event of fire, wear self-contained breathing apparatus. In the event of fire and/or explosion do not breathe fumes.
Additional information on firefighting	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**Commercial Product Name: FIS P 300 T
Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

Keep containers and surroundings cool with water spray.

SECTION 6: Accidental release measures**6.1 Personal precautions, protective equipment and emergency procedures**

Personal precautions Ensure adequate ventilation, especially in confined areas.
 Keep people away from and upwind of spill/leak.

6.2 Environmental precautions

Environmental precautions The product should not be allowed to enter drains, water courses or
 the soil.
 Prevent spreading over a wide area (e.g. by containment or oil barriers).

6.3 Methods and material for containment and cleaning up

Methods for cleaning up Use mechanical handling equipment.
 Treat recovered material as described in the section "Disposal considerations".

6.4 Reference to other sections

Reference to other sections See chapter 8/13

6.5 Additional information

Other information Dispose of in accordance with local regulations.

SECTION 7: Handling and storage**7.1 Precautions for safe handling**

Advice on safe handling None under normal processing.
 Caution: During machining in cured state dust is formed.

Advice on protection against fire and explosion No special precautions required.

7.2 Conditions for safe storage, including any incompatibilities

Storage space and container requirements Keep containers tightly closed in a cool, well-ventilated place.
 Store in accordance with local regulations.
 Keep only in original container.

Hints on storage assembly Store in accordance with the particular national regulations.

German storage class 10-13 (TRGS 510)

7.3 Specific end use(s)

Specific use(s) composite mortar
 Further information: see technical data sheet.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

SECTION 8: Exposure controls/personal protection
8.1 Control parameters
portland cement

Great Britain

Long-term exposure value/ mg / m ³	Remarks	Source
10	inhalable dust	100
4	respirable dust	100

100 - Firmendaten

ethanediol, ethylene glycol

Great Britain

Long-term exposure value/ mg/m ³	Remarks	Long-term exposure value/ ppm	Short-term exposure value / ppm	Short-term exposure value / mg/m ³	Source
10	particulate,Sk R22				19
52	vapour, Sk, R22	20	40	104	19

19 - EH40/200 Workplace exposure limits (October 2007)

Europe

Long-term exposure value/ mg/ m ³	Long-term exposure value/ ppm	Short-term exposure value / mg/ m ³	Short-term exposure value / ppm	Note	Issuing date	Source
52	20	104	40	Skin	2000/39	24

24 - DIRECTIVE 2009/161/EU

DNEL

Value	Target group	Exposure route	Exposure frequency	Source
35 mg/m ³	Workers	Inhalation	Long term effects	100
106 mg/kg	Workers	dermal	Long term effects	100
7 mg/m ³	consumer	Inhalation	Long term effects	100
53 mg/kg	consumer	dermal	Long term effects	100

100 - Firmendaten

PNEC

Value	Target group	Source
10 mg/l	freshwater	100
1 mg/l	marine water	100
199,5 mg/l	PNEC sewage treatment plant (STP)	100
20,9 mg/kg	PNEC sediment, freshwater	100
1,53 mg/kg	Soil	100

100 - Firmendaten

dibenzoyl peroxide

Great Britain

Long-term exposure value/ mg / m ³	Remarks	Source
5	R2, 36, 43	19

19 - EH40/200 Workplace exposure limits (October 2007)

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

2-methoxy-1-methylethyl acetate

Great Britain

Long-term exposure value/ ppm	Long-term exposure value/ mg/m ³	Short-term exposure value / ppm	Short-term exposure value / mg/m ³	Remarks	Source
50	274	100	548	Sk R10, 36	19

19 - EH40/2000 Workplace exposure limits (October 2007)

Europe

Long-term exposure value/ mg/ m ³	Long-term exposure value/ ppm	Short-term exposure value / mg/ m ³	Short-term exposure value / ppm	Note	Issuing date	Source
275	50	550	100	Skin	2000/39	24

24 - DIRECTIVE 2009/161/EU

8.2 Exposure controls

Respiratory protection	No personal respiratory protective equipment normally required.
Hand protection	not required under normal use
Suitable material:	butyl-rubber, Chloroprene, Nitrile rubber
Unsuitable material:	PVC disposable gloves
Material thickness:	adjust to application and duration of use
Break through time:	adjust to application and duration of use
Remarks:	Take note of the information given by the producer concerning permeability and break through times, and of special workplace conditions (mechanical strain, duration of contact).
Reference substance:	Replace when worn.
Eye protection	Tightly fitting safety goggles
Skin and body protection	Wear suitable protective equipment.
Note:	Choose body protection according to the amount and concentration of the dangerous substance at the work place.
General protective and hygiene measures	Smoking, eating and drinking should be prohibited in the application area. Avoid contact with skin, eyes and clothing. Take off all contaminated clothing immediately. Wash hands before breaks and at the end of workday. Keep away from food, drink and animal feedingstuffs. Use protective skin cream before handling the product.
Information on environmental protection regulations	No special environmental precautions required.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**Commercial Product Name: FIS P 300 T
Revision date: 30.07.2013

Version: 3.2/en



Print date: 30.07.2013

SECTION 9: Physical and chemical properties**9.1 Information on basic physical and chemical properties**

Form	paste
Colour	grey
Odour	characteristic
Odour threshold	not determined
pH	No data available
Melting point [°C]	No data available
Boiling point [°C]	no data available
Flash point [°C]	> 100 °C
Evaporation rate [kg/(s*m²)]	No data available
Flammability	No data available
Explosion limits [Vol-%]	
Lower limit:	not determined
Upper limit:	not determined
Risk of explosion.	Not explosive
Vapour pressure [kPa]	No data available
Density [g/cm³]	1,7 - 1,9 g/cm³
Temperature:	20 °C
Water solubility [g/l]	not determined
Solubility [g/l]	No data available
Partition coefficient n-octanol / water (log P O/W)	No data available
Autoinflammability	not auto-flammable
Decomposition temperature [°C]	not determined
Viscosity, dynamic [kg/(m*s)]	180 - 240 Pas
Temperature:	20 °C

9.2 Other information

Relative vapour density (air=1) not determined

SECTION 10: Stability and reactivity**10.1 Reactivity**

Thermal decomposition No decomposition if stored and applied as directed.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

10.2 Chemical stability

Chemical stability Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Hazardous reactions No dangerous reaction known under conditions of normal use.

10.4 Conditions to avoid

Conditions to avoid No decomposition if used as directed.

10.5 Incompatible materials

Materials to avoid Not applicable.

10.6 Hazardous decomposition products

Hazardous decomposition products No decomposition if used as directed.

SECTION 11: Toxicological information
11.1 Information on toxicological effects

Oral toxicity [mg/kg]

Value	Test criterion	Test species	Remarks
> 5000	LD50	rat	dibenzoyl peroxide (CAS 94-36-0)
keine - literature value			portland cement (CAS 65997-15-1)
> 5000	LD50	rat	2-hydroxypropyl methacrylate (CAS 27813-02-1)

Dermal toxicity [mg/kg]

Value	Test criterion	Test species	Duration	Remarks
> 5000	LD50	rabbit		ethanediol (CAS 107-21-1)
> 2000	LC50	rabbit	24 h	portland cement (CAS 65997-15-1)
> 5000	LD50	rabbit		2-hydroxypropyl methacrylate (CAS 27813-02-1)

Inhalative toxicity [mg/l]

Value	Test criterion	Duration of dosage	Test species	Note
4000	LD50		rat	ethanediol (CAS 107-21-1)
> 243000	LC50		rat	dibenzoyl peroxide (CAS 94-36-0)
> 5	LD50	Limit Test.	rat	portland cement (CAS 65997-15-1)

Irritant effect on skin Irritating to skin and mucous membranes

Irritant effect on eyes Irritating to eyes.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

11.2 Additional information

Other information (chapter 11.) The product itself has not been tested.

SECTION 12: Ecological information
12.1 Toxicity

Toxicity to fish [mg/l]

Value	Test criterion	Test species	Duration of dosage	Measuring method	Remarks
> 500	LC50	Leuciscus idus (Golden orfe)	96 h		ethanediol (CAS 107-21-1)
493	LC50	Leuciscus idus (Golden orfe)	48 h	DIN 38412	2-hydroxypropyl methacrylate (CAS 27813-02-1)

Toxicity to daphnia [mg/l]

Value	Test criterion	Test species	Exposure duration	Measuring method	Remarks
> 100	EC50	Daphnia magna (Water flea)	48 h	OECD Test Guideline 202	ethanediol (CAS 107-21-1)
380	EC50	Daphnia magna (Water flea)	48 h	OECD Test Guideline 202	2-hydroxypropyl methacrylate (CAS 27813-02-1)

Toxicity to algae [mg/l]

Value	Test criterion	Test species	Exposure duration	Measuring method	Remarks
> 6500	EC50	Selenastrum capricornutum	96 h		ethanediol (CAS 107-21-1)
345	EC50	Selenastrum capricornutum	72 h	OECD Test Guideline 201	2-Hydroxypropylmethacrylat (CAS 27813-02-1)

NOEC (Daphnie) [mg/l]

Value	Duration of dosage	Test species	Measuring method	Test criterion	Remarks
24,1	21 d	Daphnia magna (Big water flea).	OECD TG 202	NOEC	2-hydroxypropyl methacrylate (CAS 27813-02-1)

12.2 Persistence and degradability

Elimination and distribution mechanisms There is no data available for this product.

Elimination in purification plant There is no data available for this product.

12.3 Bioaccumulative potential

Bioaccumulation There is no data available for this product.

Bioconcentration factor (BCF) There is no data available for this product.

12.4 Mobility in soil

Distribution in the environment There is no data available for this product.

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

 Commercial Product Name: FIS P 300 T
 Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

Mobility

Mobility: There is no data available for this product.

12.5 Results of PBT and vPvB assessment

Results of PBT characteristics determination This preparation contains no substance considered to be very persistent nor very bioaccumulating (vPvB).

12.6 Other adverse effects

Further information on ecology The product itself has not been tested.

SECTION 13: Disposal considerations
13.1 Waste treatment methods

Disposal considerations The product should not be allowed to enter drains, water courses or the soil.
 Dispose of waste according to applicable legislation.
 Empty remaining contents.

Waste Code

According to the European Waste Catalogue, Waste Codes are not product specific, but application specific.
 The following Waste Codes are only suggestions:
 Product (Mortar and Curing agent)
 200127 – paint, inks, adhesives and resins containing dangerous substances
 080409 – waste adhesives and sealants containing organic solvents or other dangerous substances
 cured material and completely squeezed cartridges
 200000 – MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS

SECTION 14: Transport information

	Land transport ADR/RID	Marine transport IMDG	Air transport ICAO/IATA
UN-No	Not applicable.	Not applicable.	Not applicable.
Class	Not applicable.	Not applicable.	Not applicable.
Packaging group	Not applicable.	Not applicable.	Not applicable.
Description of the goods	No dangerous good according to ADR	No dangerous good according to IMDG	No dangerous good according to IATA
Proper shipping name		Non dangerous good	Non dangerous good
Danger releasing substance	Not applicable.	Not applicable.	Not applicable.
Environmental hazards	Not applicable.	Not applicable.	Not applicable.

14.6 Special precautions for user

Precautions not required under normal use

**Material Safety Data Sheet as per regulation (EC)
1907/2006**Commercial Product Name: FIS P 300 T
Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Transport in bulk according to not applicable
Annex II of MARPOL73/78 and
the IBC Code

14.8 Additional information

Other information (chapter 14.) Not dangerous goods in the meaning of ADR/RID, ADNR, IMDG-Code,
ICAO/IATA-DGR

SECTION 15: Regulatory information**15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture**

Additional regulations Not applicable.

15.2 Chemical safety assessment

Safety assessment Not relevant. Chemical safety assessments for substances in this mixture were not carried out.

SECTION 16: Other information

Relevant R-phrases R10: Flammable.
R22: Harmful if swallowed.
R36: Irritating to eyes.
R37/38: Irritating to respiratory system and skin.
R41: Risk of serious damage to eyes.
R43: May cause sensitisation by skin contact.

Relevant H-phrases H302: Harmful if swallowed.
H373: May cause damage to organs through prolonged or repeated exposure .
H226: Flammable liquid and vapour.
H241: Heating may cause a fire or explosion.
H315: Causes skin irritation.
H317: May cause an allergic skin reaction.
H318: Causes serious eye damage.
H319: Causes serious eye irritation.
H335: May cause respiratory irritation.

Wording of the hazard classes Skin Irrit.: Skin irritation
Eye Dam.: Serious eye damage
Skin Sens.: Skin sensitization
STOT SE: Specific target organ toxicity - single exposure
Eye Irrit.: Serious eye irritation
Acute Tox.: Acute toxicity
STOT RE: Specific target organ toxicity - repeated exposure
Org. Perox.: Organic peroxide
Flam. Liq.: Flammable liquid

**Material Safety Data Sheet as per regulation (EC)
1907/2006**

Commercial Product Name: FIS P 300 T

Revision date: 30.07.2013

Version: 3.2/en

Print date: 30.07.2013

Modifications since last version**SECTION 2 Classification according to Regulation (EC) No. 1272/2008 [CLP]****Classification for mixtures
and used evaluation method
according to regulation (EC)
1207/2008 [CLP]**

Classification	Evaluation
Skin Irrit. 2; H315	Calculated
Eye Dam. 1; H318	Calculated
Skin Sens. 1; H317	Calculated

Recommended restrictions

None under normal processing. Observe technical data sheet.

This information is provided in accordance with the current status of our knowledge and experience. The Safety Data Sheet describes products with a view to relevant safety requirements. This information does not constitute a warranty of properties, features or qualities.

12 Documentation changelog

From v8.0 to v8.1:

- Modified radar threshold range and default value
- Deleted radar recalibration column from Info frame example
- Added information about v1.2.x firmware versions

From v7.9 to v8.0:

- Added information about the new Libelium LoRaWAN Base Station

From v7.9 to v8.0:

- Added information about the new Libelium Cloud
- Deleted references to the discontinued Customer Server
- Deleted info about frames format
- Added notes about the End of Life of TTN and TTI network servers, and Libelium's end of support for them

From v7.8 to v7.9:

- Max operation temperature returned to +65 °C, since malfunctions may appear above this temperature

From v7.7 to v7.8:

- Added information about v1.0.7 and v1.1.2 firmware versions which increase the sleep time range down to 10 seconds

From v7.6 to v7.7:

- Added information about v1.0.x and v1.1.x firmware versions

From v7.5 to v7.6:

- Added information about the IP68 certification (protection against dust and water ingress)
- Added information about the IK10 certification (protection against impacts)
- Max operation temperature increased to +85 °C (no-continuously)

From v7.4 to v7.5:

- Deprecated the “Keep-alive night-mode” setting in all configuration forms: Smart Parking Cloud Service, Customer Server and Smart Devices App
- Added new section to describe the Smart Parking Node’s label with device’s specifications
- Updated all released firmware versions

From v7.3 to v7.4:

- Added information to enable the integration of the following 3 LoRaWAN Network Servers into the “Smart Parking Cloud Service” scenario: The Things Network, The Things Industries and MultiTech basestation’s Embedded Network Server

From v7.2 to v7.3:

- Added information to enable the integration of the following 3 LoRaWAN Network Servers into the “Customer Server” scenario: The Things Network, The Things Industries and MultiTech basestation’s Embedded Network Server
- Added diagram and dimensions of the vaulted enclosure
- Added info about the Customer Server: multiple instances, extract info and upgrade
- Errata correction

From v7.1 to v7.2:

- Added Loriot license type recommendation
- Changed Loriot batch import format due to the new Loriot Network Server 5.0

From v7.0 to v7.1:

- Added safety guide for Smart Parking Chemical Fixing Cartridge
- Errata correction