

Smart Parking

Technical Guide



Document version: v7.5 - November 27, 2019

© Libelium Comunicaciones Distribuidas S.L.

INDEX

1. Introduction	6
2. Network architecture	7
2.1. Smart Parking node	8
2.2. LoRaWAN base station	8
2.3. LoRaWAN Network Server	8
2.4. Libelium Smart Parking Cloud Service and Customer Server	9
3. Smart Parking node	11
3.1. Hardware description	11
3.1.1. Node versions	13
3.1.2. LoRaWAN regions	13
3.1.3. LoRaWAN protocol and parameters	13
3.1.4. Identification label	14
3.2. Power and time consumption	14
3.2.1. Smart Parking EU	15
3.2.2. Smart Parking US	15
3.3. User switches	15
3.4. Reset button	16
3.5. Node setup	16
3.5.1. "Ready to install" state	16
3.5.2. How to close the Smart Parking node	17
3.5.3. "Magnet start-up" process	18
3.6. How the node works	19
3.6.1. Frame types	19
3.6.2. Frame header	20
3.6.3. Frame payload	20
3.6.4. Node program flowchart	22
3.7. Node parameters	23
3.7.1. Parameters description and ranges	23
3.7.2. Understanding Info and Keep-alive frames	24
3.7.3. Understanding night-mode	24
3.7.4. Understanding RTC synchronization	25
3.7.5. Understanding uplink frames format (real example)	26
3.7.6. Factory default values	27
3.7.7. Configure new parameter values	28
4. Libelium Cloud management	29
4.1. Introduction to the Libelium Services Cloud Manager - SCM	29
4.2. SCM account	30

4.2.1.	Creating an account.....	30
4.2.2.	Signing in	31
4.3.	Smart Parking nodes registration	32
4.4.	Editing Smart Parking nodes.....	33
4.5.	Export CSV file with nodes credentials	34
5.	Smart Devices App.....	36
5.1.	How to install the Smart Devices App	36
5.1.1.	Start Smart Devices App on Windows.....	37
5.1.2.	Start Smart Devices App on GNU/Linux	38
5.1.3.	Start Smart Devices App on MacOSX.....	38
5.2.	Upgrading the Smart Devices App	38
5.3.	Smart Parking v2	38
5.3.1.	How to plug the Smart Parking node.....	39
5.3.2.	Configuration	39
5.3.3.	Programmer (change node parameters)	40
5.3.4.	Firmware upgrade.....	41
5.3.5.	Factory Reset	43
6.	LoRaWAN Network Server setup	44
6.1.	Loriot.....	44
6.1.1.	Log in	44
6.1.2.	Create a new Loriot application.....	45
6.1.3.	Manage Loriot output data	46
6.1.4.	How to delete unused Loriot applications	47
6.1.5.	How to create a single device manually	48
6.1.6.	Nodes batch provisioning in Loriot	49
6.2.	Activity.....	51
6.2.1.	How to create a new Application Server.....	51
6.2.2.	How to create a new AS routing profile.....	53
6.2.3.	How to create new devices manually.....	55
6.2.4.	Nodes batch provisioning in Activity	56
6.3.	The Things Network (TTN)	58
6.3.1.	Log in	58
6.3.2.	Manage gateways	60
6.3.3.	Manage applications.....	62
6.4.	The Things Industries (TTI)	70
6.4.1.	Log in	70
6.4.2.	Manage gateways	71
6.4.3.	Manage applications.....	73
6.5.	MultiTech basestation	82
6.5.1.	Libelium's Custom App.....	82
6.5.2.	Compatible firmware versions	87
6.5.3.	Installing/upgrading Custom App	87

7. Customer Server.....	92
7.1. Installation.....	93
7.1.1. Docker	93
7.1.2. Server	93
7.2. Deploying	93
7.2.1. Docker	93
7.2.2. Server	94
7.3. Configuring the application	95
7.3.1. How to configure Lorient.....	97
7.3.2. How to configure Activity.....	98
7.3.3. How to configure The Things Network (TTN).....	98
7.3.4. How to configure The Things Industries (TTI)	100
7.3.5. How to configure a MultiTech basestation.....	102
7.4. Making the server accessible from anywhere.....	103
7.4.1. Configuring a domain pointing to the customer server	103
7.5. Remote Configuration Form	103
7.6. Customer Server Core	105
7.6.1. End-point	105
7.6.2. Data Parser	105
7.6.3. Database.....	105
7.7. Modifying the Customer Server.....	108
7.7.1. Extracting data from the Customer Server	108
7.7.2. Modifying the Database	109
7.7.3. Adding a new unsupported LoRaWAN Network Server	109
7.8. Upgrading the Customer Server	110
8. Libelium Smart Parking Cloud Service	112
8.1. Smart Parking Cloud Service	112
8.1.1. Remote configuration	113
8.1.2. Service configuration	115
8.1.3. Log.....	123
8.1.4. Tools	124
9. Deployment and installation.....	127
9.1. Step-by-step guideline	127
9.2. How to place the nodes	128
9.3. Node installation.....	129
9.3.1. Triple installation option.....	129
9.3.2. On-surface node installation	130
9.3.3. Underground node installation	135
9.3.4. Semi-underground node installation.....	138
9.4. Node start-up	139
9.5. Working example	140

10. Certifications	141
10.1. CE (European Union)	141
10.2. FCC (United States)	141
11. Safety Guides	142
11.1. Smart Parking Chemical Fixing Cartridge	142
12. Documentation changelog	154

1. Introduction

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



Figure : Smart Parking node developed by Libelium

The node applies intelligent algorithms to detect changes in the state of the parking slot. Then data is transmitted with the LoRaWAN radio to the final server.



Figure : Simplified Smart Parking network architecture

The nodes provisioning has been enormously improved. The nodes are delivered with default time settings and also 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 improves the detection and stability performance thanks to a radar sensor which permits to certainly know when objects are placed over the device. The next table shows a comparative analysis of the current sensor technologies in the Smart Parking market:

The node provides OTA-S (Over-The-Air Setup). This allows the user to remotely configure the node parameters (sleep time, keep-alive, night-mode, etc) via the Remote Configuration Form. That makes it possible to directly install the nodes with factory default settings and then update them from the server side.

Figure : Remote Configuration Form

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 Smart Parking Cloud Service or Customer Server

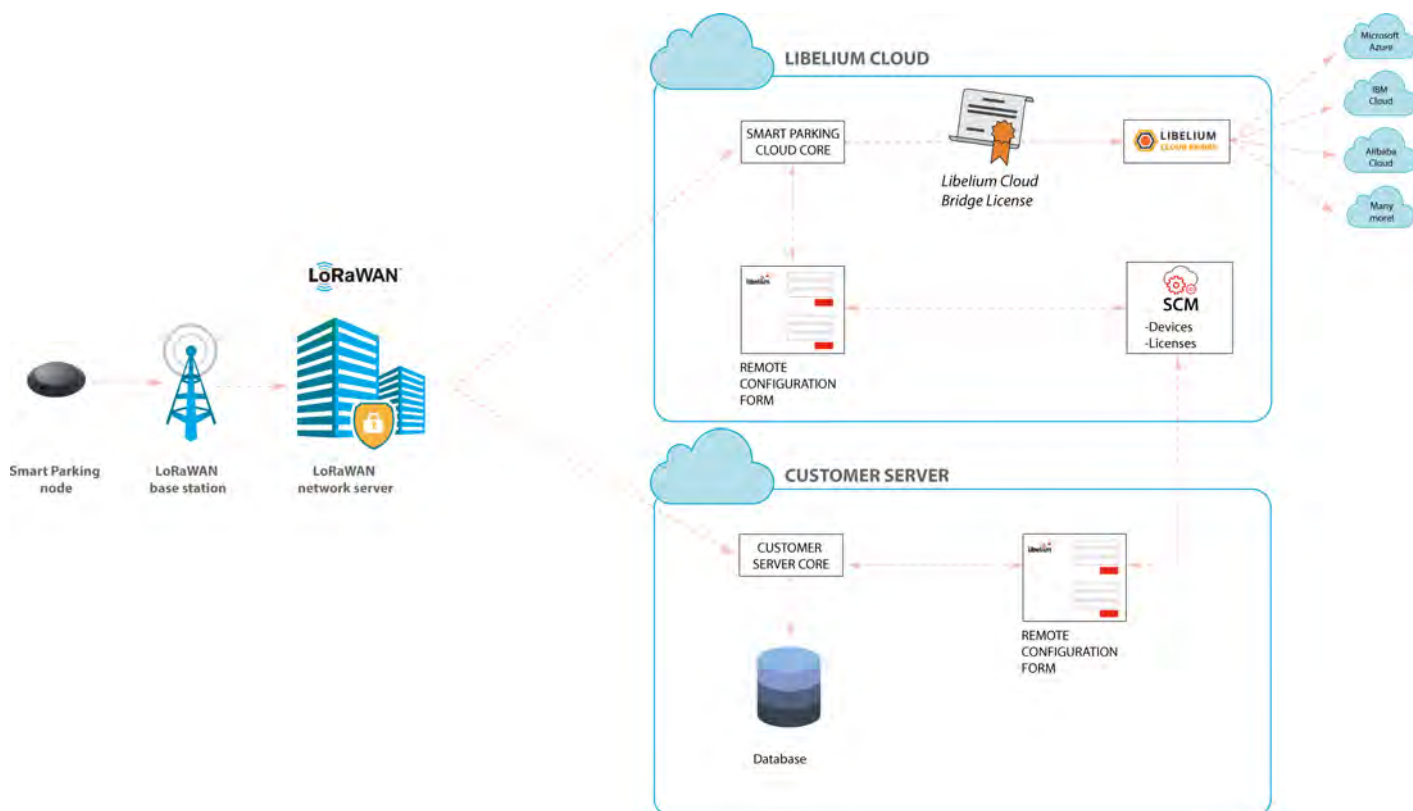


Figure : Smart Parking network architecture

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 : 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 : 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 the

Libelium Smart Parking Cloud Service or to the Customer Server.

2.4. Libelium Smart Parking Cloud Service and Customer Server

The LoRaWAN Network Server connects to the final server, which can be the Libelium Smart Parking Cloud Service or the Customer Server.

The LoRaWAN network servers currently supported are:

- Lorient
- Actility
- The Things Network
- The Things Industries
- The Embedded Network Server inside MultiTech base stations

If the customer wants to use a new LoRaWAN Network Server, then the Data Parser block must be modified in order to receive data properly. Keep in mind that each Network Server implements its own HTTPS callback using a different format.

The Remote Configuration Form allows the user to update the settings of each node (sleep time, keep-alive time, night-mode, etc). The update is done remotely via LoRaWAN downlink radio packets.

The difference between the 2 types of server differ in the the possible client needs:

- The Customer Server is a software system provided by Libelium which permits to receive, decode and insert data into a standard MySQL database. It is mandatory that the user sets up her own server to host the Customer Server. Read the "[Customer Server](#)" chapter for further information.
- The Smart Parking Cloud Service is a software service provided by Libelium which permits to receive, decode and redirect the data to the final 3rd party IoT cloud (Amazon, Azure, etc). This retransmission is done thanks to the cloud connectors running on another Libelium Cloud's service: the Bridge. Read the "[Libelium Smart Parking Cloud Service](#)" chapter for further information.

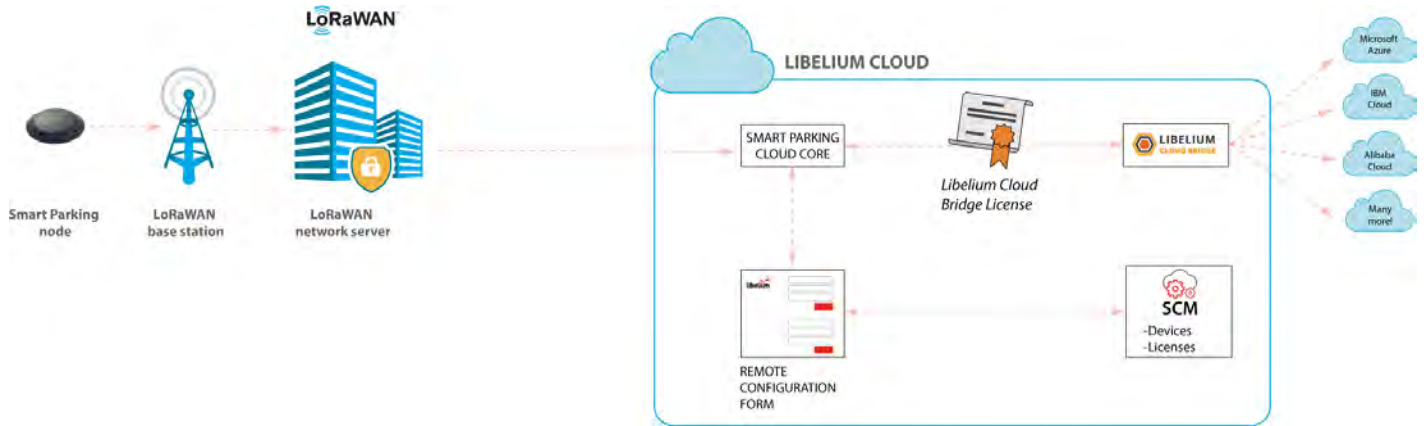


Figure : Libelium Smart Parking Cloud Service scenario

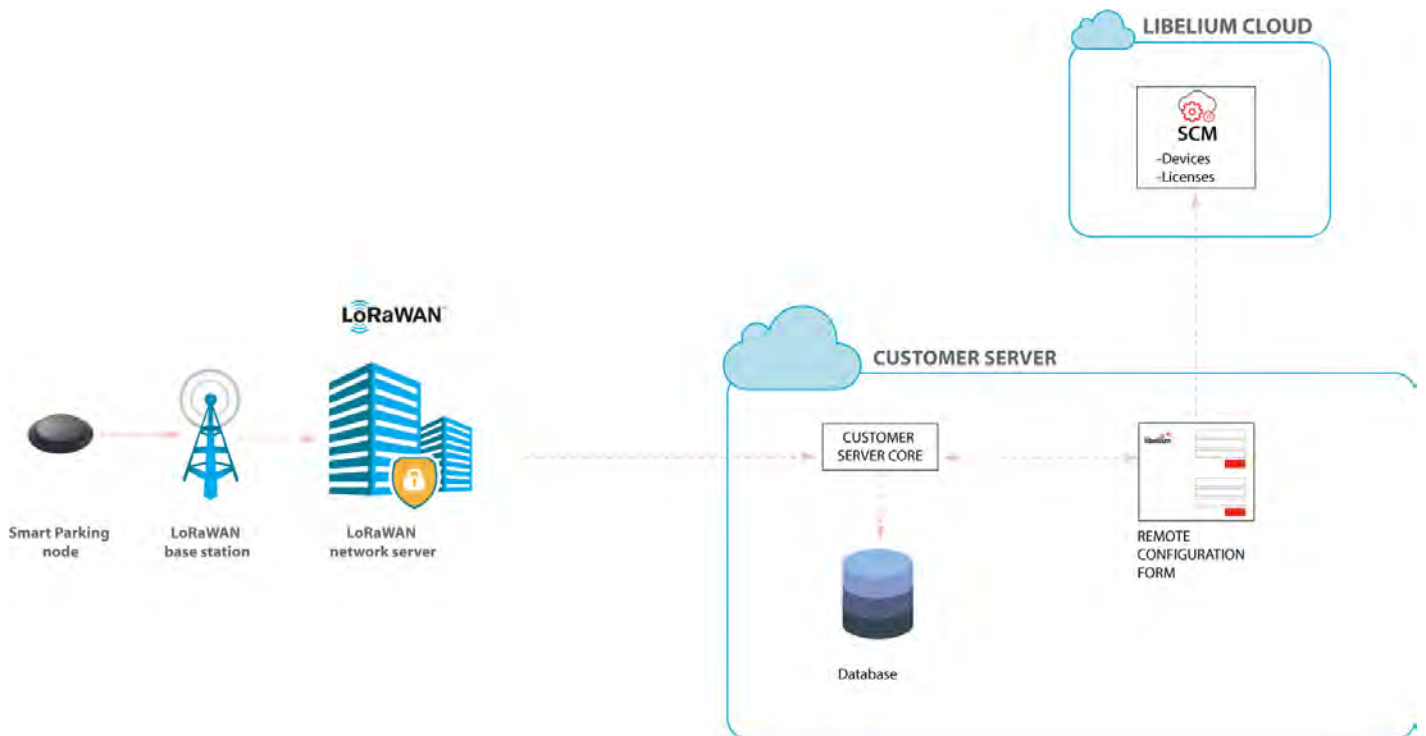


Figure : Customer Server scenario

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.



Figure : Base of a Smart Parking node

The base is screwed to the external enclosure piece:



Figure : External enclosure

The next table shows the basic Smart Parking node characteristics.

Enclosure dimensions	37.25 mm x 200 mm
Power supply	Built-in lithium-thionyl chloride (Li-SOCl ₂) batteries; expected lifetime of 4-10 years*
Configurable sleep time	Min: 20 s / max: 10 min
Radio protocol	LoRaWAN module
Dual detection	Radar (main) and magnetic (backup)
Provisioning	Ready to install (default LoRaWAN OTAA IDs and key are loaded to each node)
Node configuration	Via "Remote Configuration Form" (web form)
LoRaWAN configuration	Via "Smart Devices App" (Java desktop application)
Operating temperature	-20 to +65 °C

(*) Under normal circumstances and depending on settings

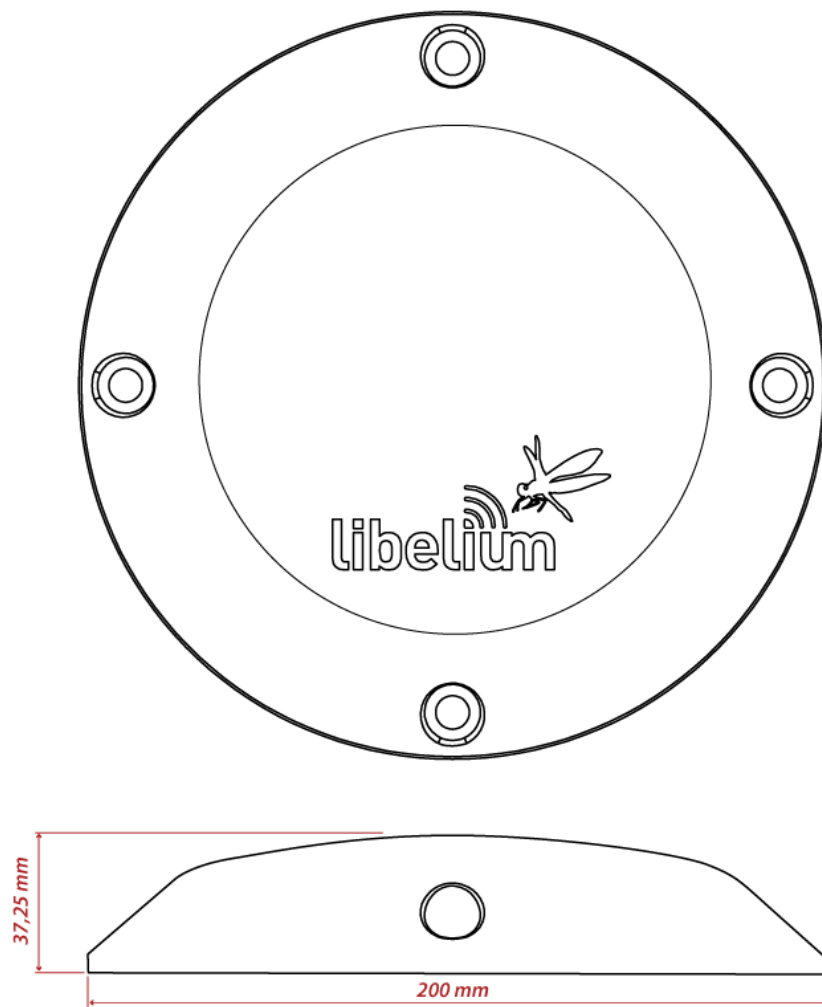


Figure : Vaulted enclosure dimensions

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. 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](#).

3.1.3. 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](#).

3.1.4. 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 : 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 : Smart Parking node "user 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.

Important:

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 : Reset button

3.5. Node setup

3.5.1. "Ready to install" state

Important:

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 : The red LED blinks once to indicate ready-to-install state

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 : Screws 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 : Enclosure position marks

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



Figure : 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, "[Smart Devices App](#)" 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 : 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.

Important:

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	#num	Description
Start frame 1	4	First frame sent by the node when starting (with params settings)
Start frame 2	5	Second frame sent by the node when starting (with params settings)
Info frame	0	Used to inform a Parking Status change
Keep-alive frame	1	Used to inform the device keeps working since last reported status
Configuration uplink	2	Used to confirm a "Configuration downlink" was applied or not
RTC update request	7	Used to request for an RTC sync once every day

The next table shows the Downlink frames:

Frame type	#num	Description
Configuration downlink	3	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	6	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.

Header	Payload
2 bytes	9 bytes

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.

3.6.2. Frame header

The "Header" included in each uplink frame contains 2 bytes:

Byte	Bit	Field
0	7	Parking lot status
0	6	Battery state
0	5	Configuration uplink acknowledgement
0	4	Sensor recalibration
0	3-0	Frame type
1	7-0	Sequence number

The meaning of each field is:

- Parking slot status:
 - 0: Free
 - 1: Occupied
- Battery status:
 - 0: OK
 - 1: Warning. The battery level measured is below the warning threshold (3340 mV)
- Configuration uplink frame acknowledgement status:
 - 0: ACK
 - 1: NACK
- Sensor recalibration:
 - 0: No calibration was done since the last uplink
 - 1: At least one calibration was done since the last uplink
- Frame type: Number related to frame type
 - 0: Info frame
 - 1: Keep-alive frame
 - 2: Configuration uplink frame
 - 3: Configuration downlink
 - 4: Start frame 1
 - 5: Start frame 2
 - 6: RTC sync frame
 - 7: RTC update request
- Sequence number: This is a 1-byte field so the sequence number goes from 0 to 255. When 255 is reached, the counter starts from zero again.

3.6.3. Frame payload

The "Payload" contents vary depending on each frame type.

The Start frame 1 frame contents are:

- Header ("Parking slot status" does not provide valid data)
- Firmware version:
 - From 1 to 8: Not released firmware versions
 - 9: v1.0.0
 - 10: v1.0.1
 - 11: v1.0.2
 - 13: v1.0.4
 - 14: v1.0.5
 - 16: v1.0.6 (last stable version)
- Battery level
- Radar settings (threshold and range)
- LoRaWAN settings (join mode and ADR)

The Start frame 2 frame contents are:

- Header ("Parking slot status" does not provide valid data)
- Sleep and Keep-alive time settings
- Night-mode settings (enabled/disabled, start hour, duration, sleep time)

The Info frame contents are:

- Header
- Sensor error
- Temperature
- Timestamp (hour and minutes)
- Radar measurement (Distance, amplitude and number of reflections)

The Keep-alive frame contents are:

- Header
- Sensor error
- Temperature
- Timestamp (hour and minutes)
- Radar measurement (Distance, amplitude)
- Battery level

The RTC update request frame contents are the same as Keep-alive frame.

Important:

The Customer Server provides the needed source code to parse this data into a more comprehensive structure. The Libelium Cloud Bridge also provides the needed tools to transmit the parsed data to a 3rd party IoT cloud. For more information, please refer to the "[Customer Server](#)" section.

3.6.4. Node program flowchart

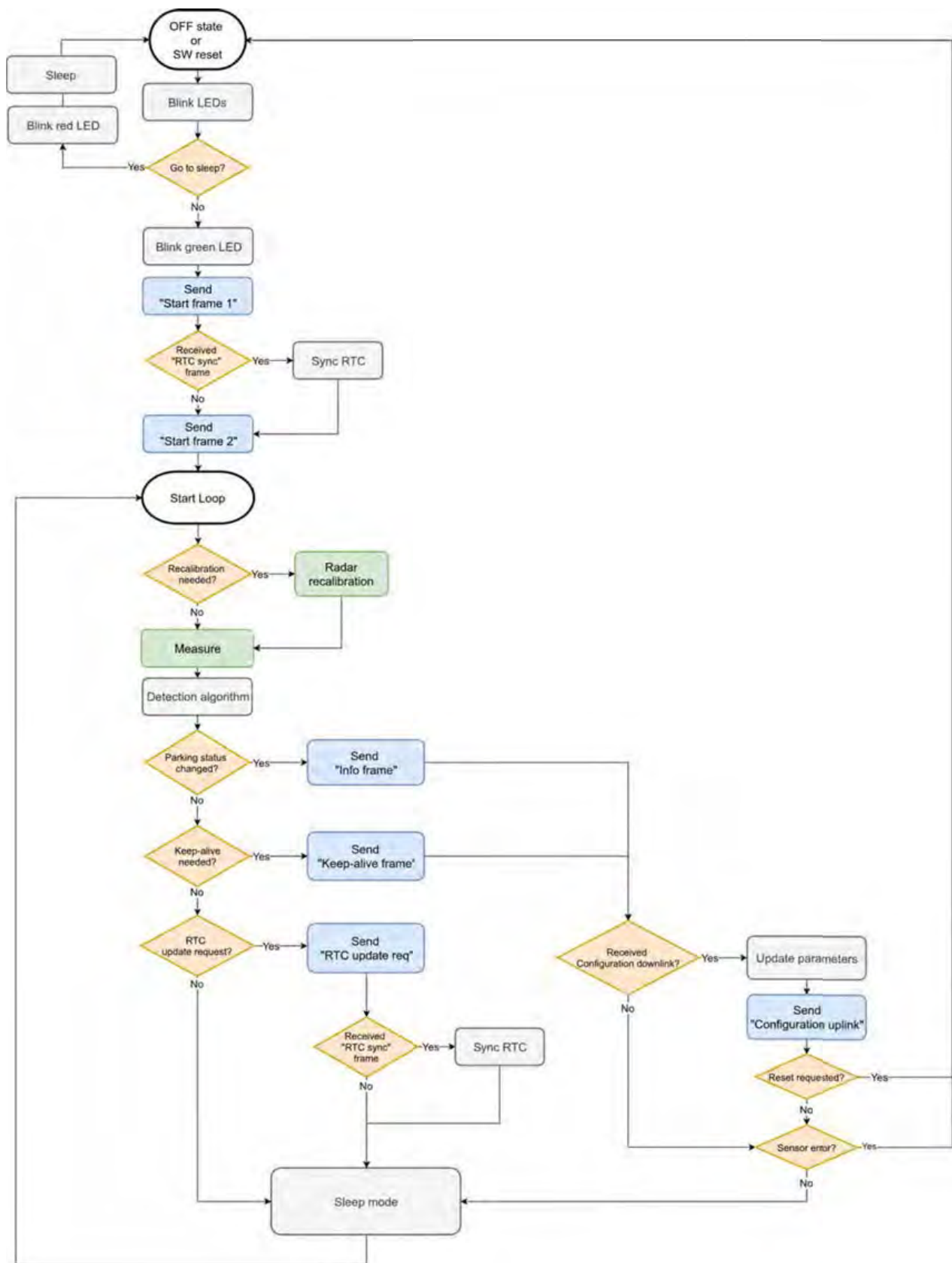


Figure : Smart Parking node program flowchart

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 20-59 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	5 to 100	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)

Important:

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

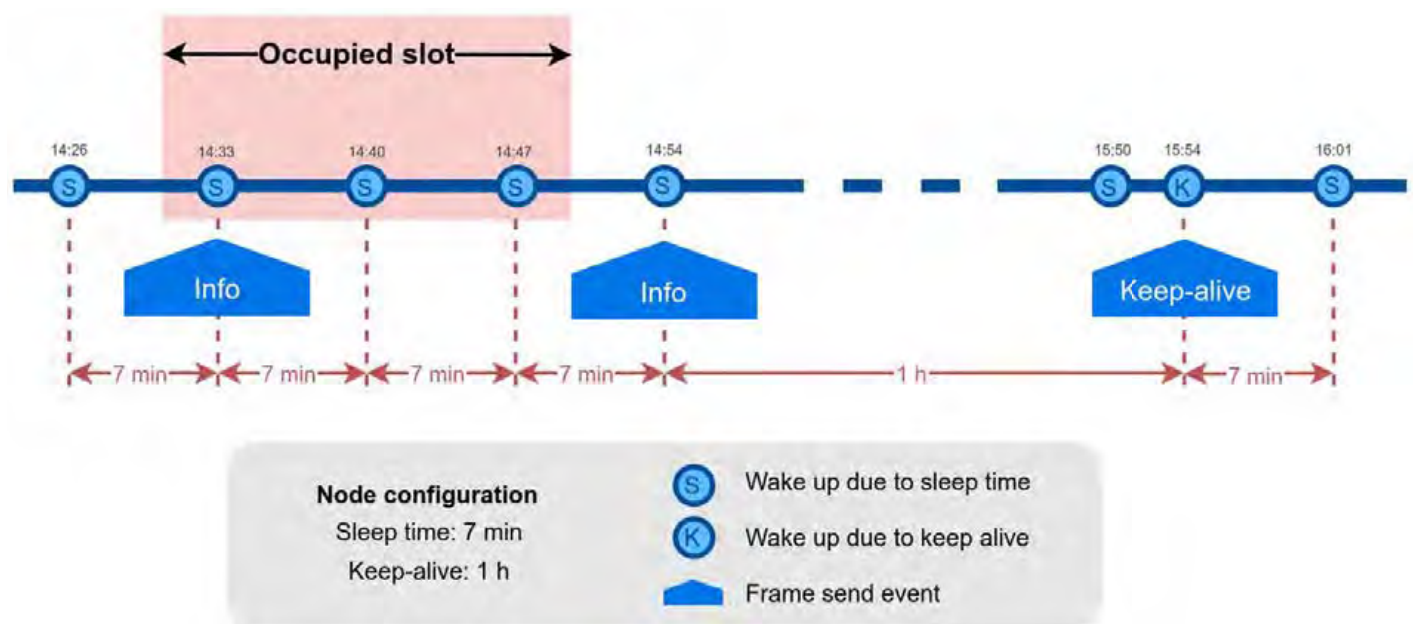


Figure : Example Info and Keep-alive frames

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.

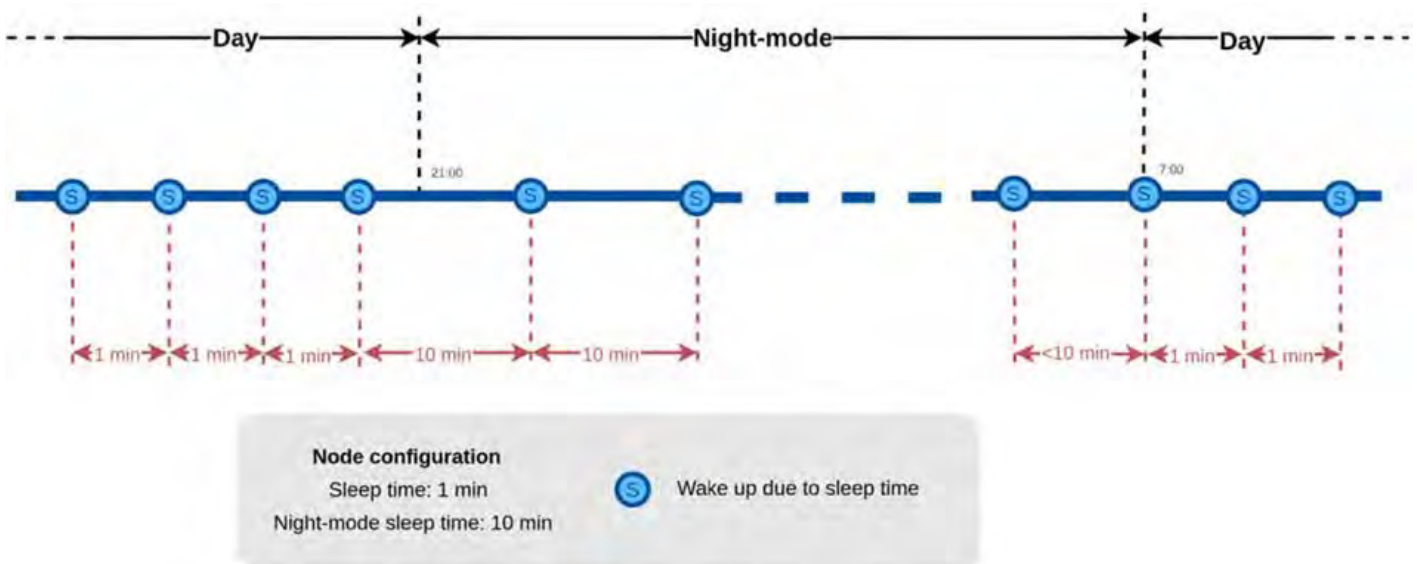


Figure : Example of day and night mode

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.

Note: 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 : Example of RTC sync

Note: 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	Uplink data	F. Type	Parking lot	Battery	Recal	Seq
04/15/19 15:59	040009c419143c01000000	4 (Start 1)	NULL	0	0	0
04/15/19 15:59	0501010000011608050200	5 (Start 2)	NULL	0	0	1
04/15/19 15:59	110200170f3b00000000b0	1 (Keep-alive)	0	0	1	2
04/15/19 17:29	01030013101d00000000c8	1 (Keep-alive)	0	0	0	3
04/15/19 19:29	1104000d131d00000000d4	1 (Keep-alive)	0	0	1	4
04/15/19 21:29	0105000a151d00000000d4	1 (Keep-alive)	0	0	0	5
04/16/19 23:29	0106000a173b00000000d5	1 (Keep-alive)	0	0	0	6
04/16/19 01:29	01070009040000000000d4	1 (Keep-alive)	0	0	0	7

04/16/19 03:29	01080008060000000000d5	1 (Keep-alive)	0	0	0	8
04/16/19 05:29	01090008060000000000d5	1 (Keep-alive)	0	0	0	9
04/16/19 06:04	800a000906040172410005	0 (Info)	1	0	0	10
04/16/19 08:04	810b000a0804016d4268d4	1 (Keep-alive)	1	0	0	11
04/16/19 10:04	810c000b0a04017b3e00d4	1 (Keep-alive)	1	0	0	12
04/16/19 12:04	810d000c0c04016d3e58d4	1 (Keep-alive)	1	0	0	13
04/16/19 14:05	810e000e0e05016f3e80d4	1 (Keep-alive)	1	0	0	14
04/16/19 15:58	870f000f0f3b016b3dd0d4	7 (RTC request)	1	0	0	15
04/16/19 15:59	8710000f0f3b016b3dd0d4	7 (RTC request)	1	0	0	16
04/16/19 17:59	8111000f101c016e3c98c7	1 (Keep-alive)	1	0	0	17
04/16/19 18:32	002a000f101f0000000000	0 (Info)	0	0	0	18
04/16/19 20:02	012b0010110100000000c7	1 (Keep-alive)	0	0	0	19
04/16/19 22:32	012c0011111f00000000c8	1 (Keep-alive)	0	0	0	20
04/17/19 00:02	012d0010120100000000c7	1 (Keep-alive)	0	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
Radar range start	20 cm (should not be changed)
Radar range length	60 cm (should not be changed)
Radar threshold	25 (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

The Smart Devices App and the Remote Configuration Form allow the user to configure new parameters to the node. The 1st one is a desktop Java application which implies opening the node enclosure and plug a micro-USB cable to the node. The 2nd one is a form allocated in the Libelium Smart Parking Cloud Service or in the Customer Server, which 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).

Note: For further information about this matter please refer to the [“Smart Devices App”](#) and [“Remote Configuration Form”](#) sections.

4. Libelium Cloud management

4.1. Introduction to the Libelium Services Cloud Manager - SCM

According to the Smart Parking network architecture, users can select between 2 ways of working with the Smart Parking nodes: one using the Customer Server, and the other using the Smart Parking Cloud Service. Regardless of the solution chosen, users will always need to operate with the Services Cloud Manager (SCM), which is the basis of the Libelium Cloud.

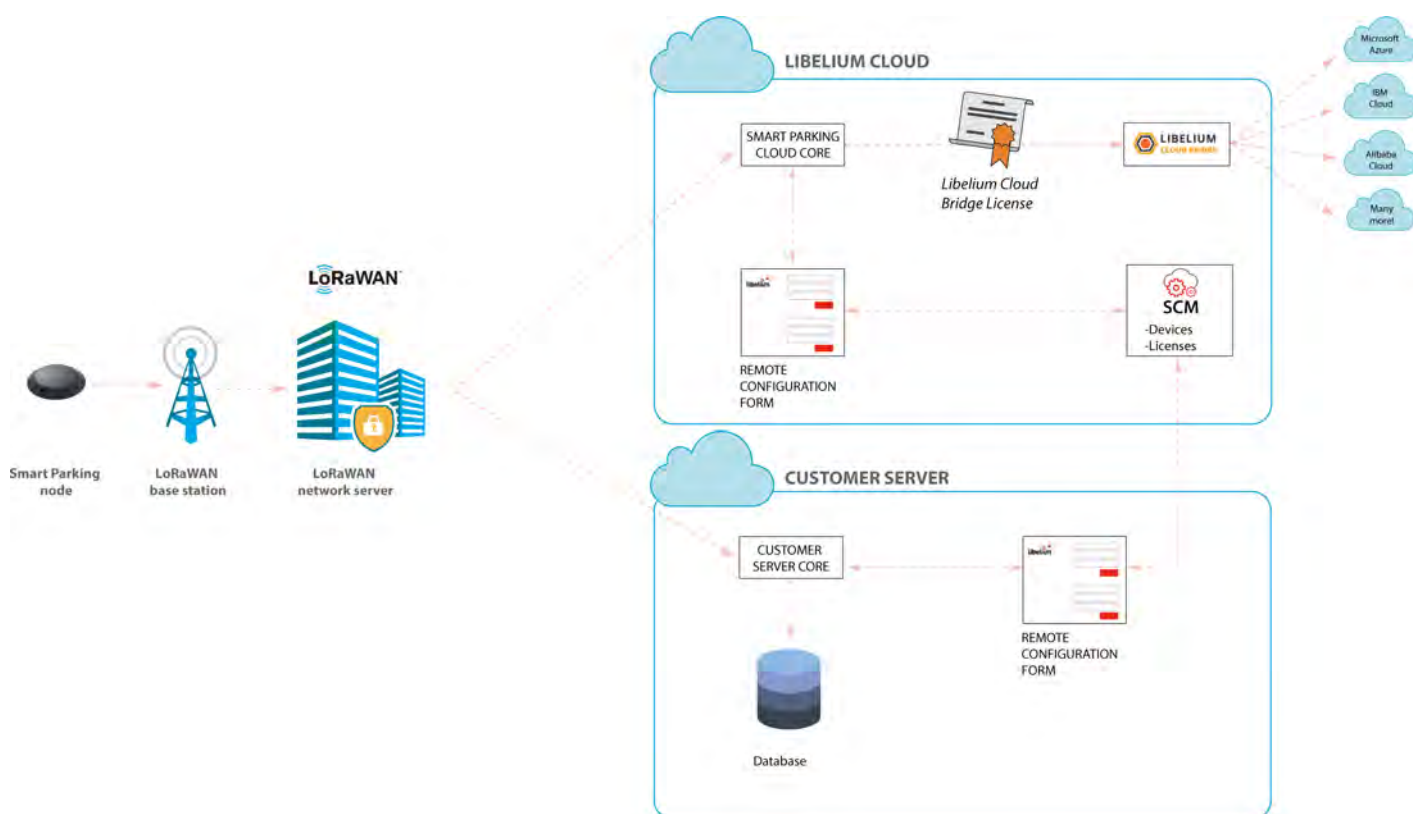


Figure : Smart Parking network architecture

4.2. SCM account

This is the 1st step users must follow. Anyone can create a new account in the SCM for free. This account will allow you to manage your Libelium devices and also all your licenses and services. You can access the SCM at <https://cloud.libelium.com>.

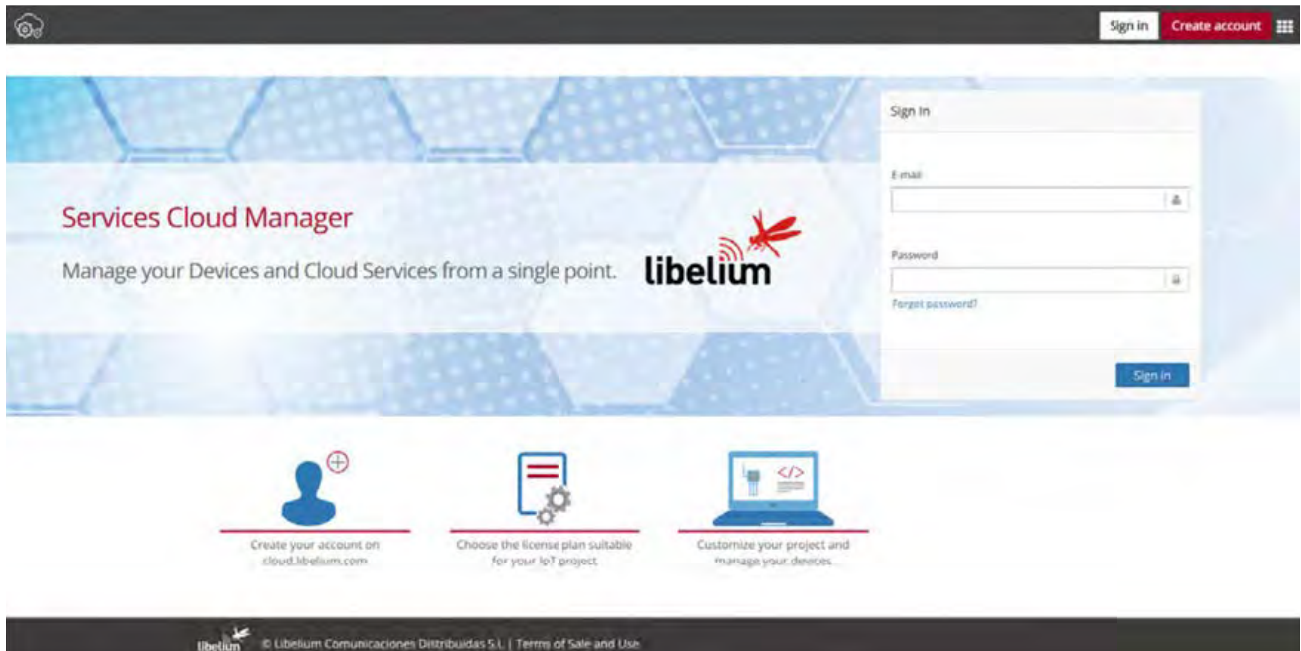


Figure : SCM Home page

4.2.1. Creating an account

To register and set up a password, go to <https://cloud.libelium.com/register> and click on "Create account".

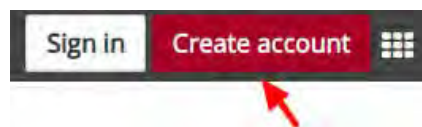
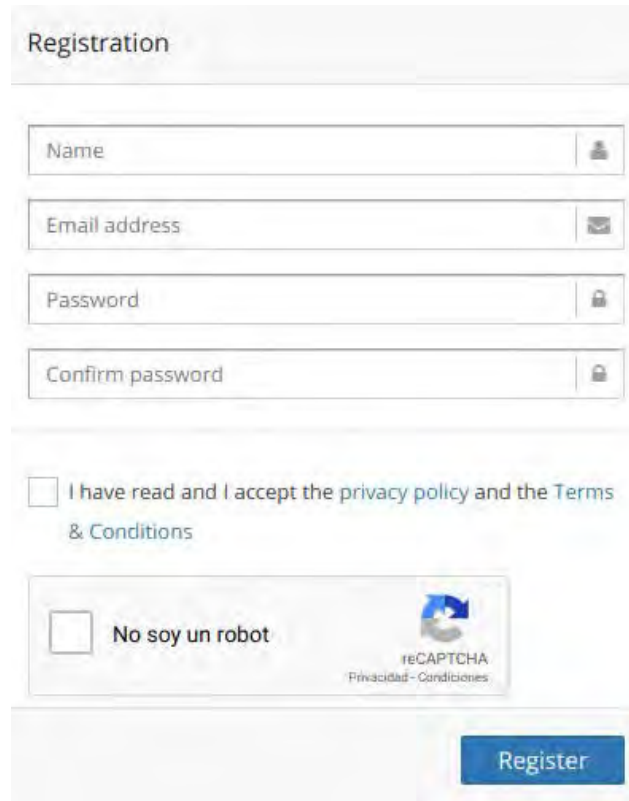


Figure : "Create account" button


Complete the information in the form (all the fields are mandatory):


- Name: Your name
- E-mail address: A valid e-mail address, it will be used for verification purposes
- Password and Confirm password: Set your password


Accepting Terms & Conditions is also mandatory to create a new account in the SCM.




Registration


Name 

Email address 

Password 

Confirm password 

☐ I have read and I accept the [privacy policy](#) and the [Terms & Conditions](#)

☐ No soy un robot  reCAPTCHA
Privacidad - Condiciones

Register

Figure : Create account form

4.2.2. Signing in

To sign in the SCM, go [here](#) and click on the "Sign In" button.

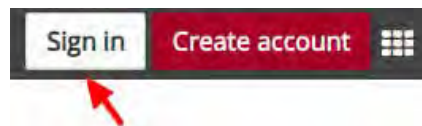
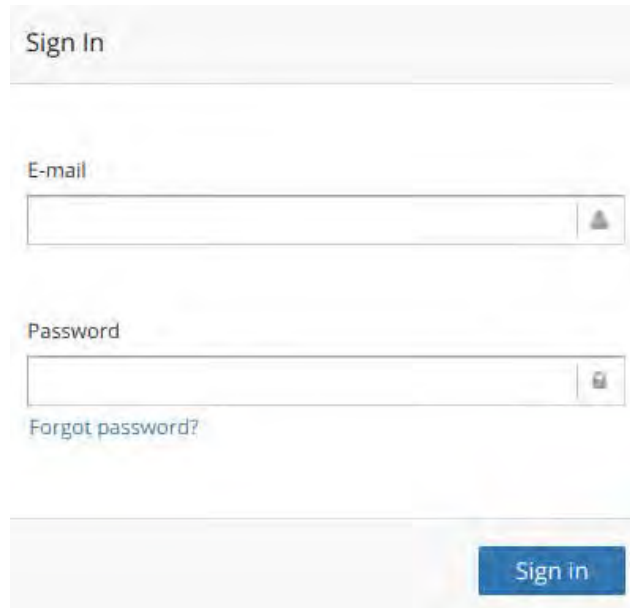


Figure : "Sign-in" button

Complete the information in the form. The e-mail and password used when creating the account will be required:

- E-mail address: E-mail address used for registration
- Password: Password used for registration



The sign-in form is a light gray rectangular box. At the top left, it says "Sign In". Below this, there are two input fields: "E-mail" and "Password". Each field has a small icon on the right side (a person for email, a lock for password). Below the password field, there is a link that says "Forgot password?". At the bottom right of the form, there is a blue button with the text "Sign in".

Figure : Sign-in form

The Terms & Conditions accepted when creating the account apply for any time you sign in the SCM. If you do not have an account yet, follow the steps described on the section "Create an account" to obtain valid credentials. If you already created an account and need a password reminder, you can click on "Forgot password?".

4.3. Smart Parking nodes registration

After placing an order including Smart Parking nodes you should receive an e-mail with the activation codes for all your devices. In this e-mail you will directly find clickable links to register the devices in the SCM. You can register your nodes one by one if needed, but it's faster to register all of them at once with the global Activation Code.



Figure : Activation codes e-mail

By clicking on these links you will be able to complete the registration process by following the wizard:

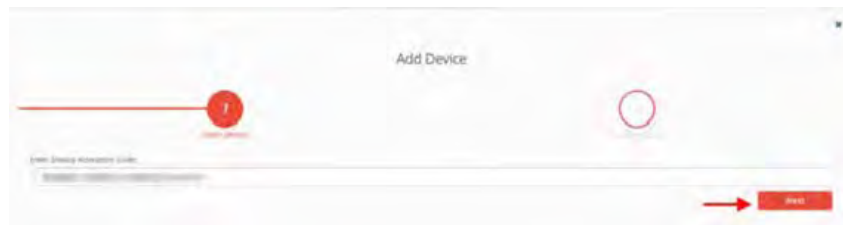


Figure : Step1. Enter device activation code

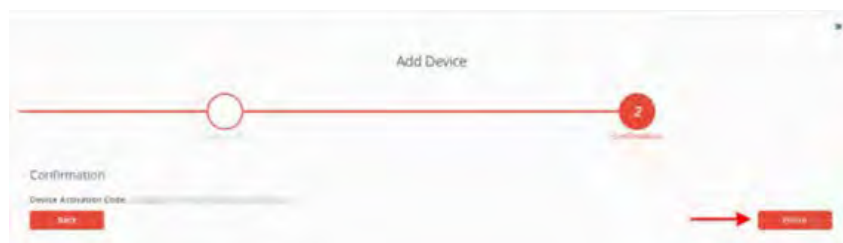







Figure : Step2. Confirm activation

4.4. Editing Smart Parking nodes

You can change the "name", "project", "description" and (if the device is a Smart Parking node) the "LoRaWAN EUI" of the device by clicking the pencil icon located next to the each device. Finally you must save the changes.

<input type="checkbox"/>		Smart Parking	Smart Par
<input type="checkbox"/>		Smart Parking	Smart Par
<input type="checkbox"/>		Smart Parking	Smart Par
<input type="checkbox"/>		Smart Parking	Smart Par
<input type="checkbox"/>		Smart Parking	Smart Par

Edit Device

Names:

Project:

Description:

LoRaWAN EUI:

Close Save changes

Figure : Edit a device

4.5. Export CSV file with nodes credentials

The SCM allows the user to export all nodes credentials via HTTPS secure connection. The exported file is a CSV file with all credentials needed for OTAA join mode. The exported LoRaWAN credentials are the same as they were configured by factory default. This means that if the user changed the LoRaWAN credentials via "Smart Devices App", then the exported credentials will not be same.

In order to export the file, you must go to <https://cloud.libelium.com>, log in and then access "My Devices". On the website you will identify the "Smart Parking actions" button which permits to download the nodes credentials by clicking on the "Download nodes keys" button.



Figure : Export CSV file with all nodes credentials

The CSV file for 'N' devices exported from the SCM follows the next format:

```
<DevEUI_1>,<Serial>,<AppEUI_1>,<AppKey_1>  
<DevEUI_2>,<Serial>,<AppEUI_2>,<AppKey_2>  
<DevEUI_3>,<Serial>,<AppEUI_3>,<AppKey_3>  
...  
<DevEUI_N>,<Serial>,<AppEUI_N>,<AppKey_N>
```

5. Smart Devices App

Libelium Smart Devices App is an software tool developed by Libelium that allows users install new firmware versions and program the configuration of the new Libelium devices in a few clicks. At the moment it is only available for Smart Parking and MySignals products, but the list will be incremented shortly.

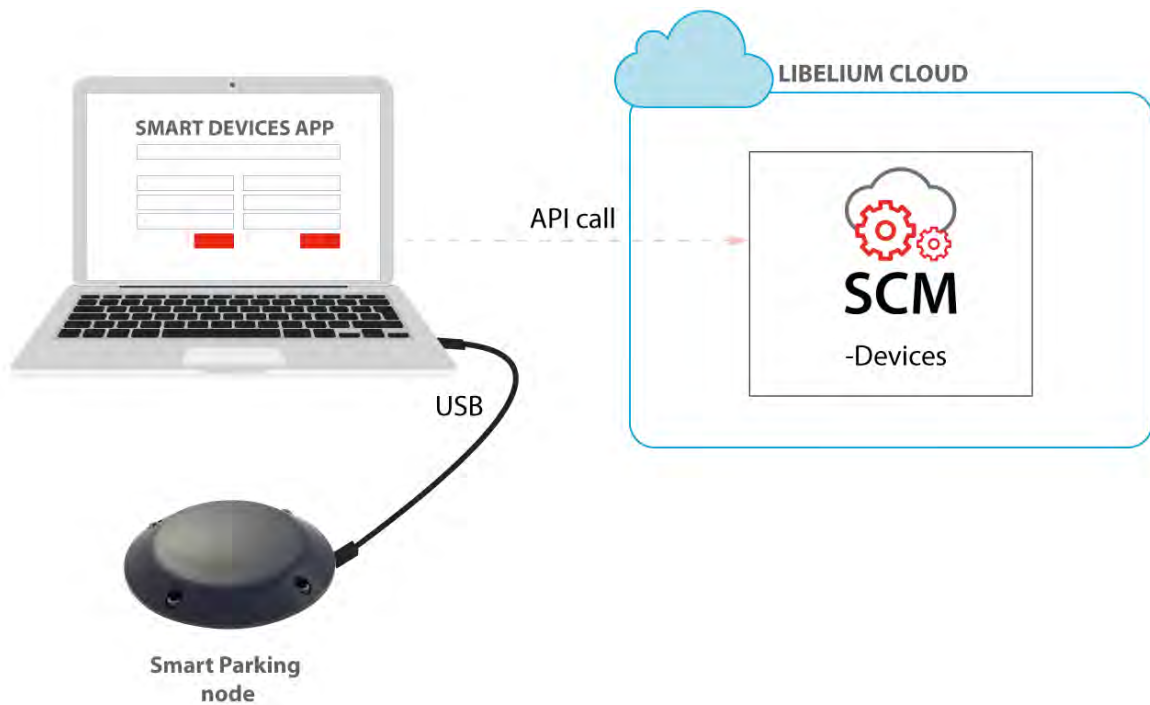


Figure : Smart Devices App is connected to the node via USB

5.1. How to install the Smart Devices App

First of all and before installing anything, users have to take into account the platform where the application is going to be installed. To install the Smart Devices App , it is compulsory to have installed the JRE 1.8 or JDK 1.8. If it is not installed in the computer, you can download it from the website below and follow the steps described:

https://docs.oracle.com/javase/8/docs/technotes/guides/install/install_overview.html
<https://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html>

Once installed JDK or JRE, users can download the application in the link below, selecting the appropriate Operating System and architecture:

<http://www.libelium.com/development/smart-parking/software-and-applications>

Then customers only have to extract the content of the SmartDeviceApp zip file downloaded in a place with the right permissions, and finally execute the file called "SmartDeviceApp" that will initialize the application. Please, note that the extension of this file will depend on the operating system the user is using at the moment (.sh for Linux and OSX, and .bat for Windows).

This new Smart Devices App uses a new programmer under the hood called STM32CubeProgrammer, so it is a good practice to before using the Smart Devices App :

<https://www.st.com/en/development-tools/stm32cubeprog.html>

Windows systems

It is important to install STM32CubeProgrammer as the software contains the drivers needed to set the USB ports in DFU mode, if you want to know more about how to install this software and know about how to set the USB in DFU mode, please see the official guide from STM32CubeProgrammer:

[Link to ST documentation.](#)

Make sure that your USB can switch to DFU mode, you can check it with the STM32CubeProgrammer.

MacOS systems

It is not necessary to install additional software, but you can install STM32CubeProgrammer:

<https://www.st.com/en/development-tools/stm32cubeprog.html>

GNU/Linux systems

It is necessary to change permissions to USB ports. If you have problems with your USB device on your GNU/Linux (or the Smart Devices App does not recognize the SmartParking v2 device) you can compile the *stlink driver discover*:

```
git clone https://github.com/texane/stlink.git stlink
cd stlink
make
# install binaries:
sudo cp build/Release/st* /usr/local/bin/
# install udev rules
sudo cp etc/udev/rules.d/49-stlinkv* /etc/udev/rules.d/
# and restart udev
sudo udevadm control --reload
```

If you have problems with stlink driver installation please refer this site: <https://github.com/texane/stlink>.

Review the UDEV rules and they should be as follows:

```
nano /etc/udev/rules.d/49-stlinkv2.rules
SUBSYSTEMS=="usb", ATTRS{idVendor}=="0483", ATTRS{idProduct}=="3748", \
    MODE=="0666", \
    SYMLINK+="stlinkv2_%n"
```

Add your user to **dialout**:

```
sudo addgroup <username> dialout
```

Then you will be able to use the USB ports on Linux systems. It is also recommended to install *STM32CubeProgrammer* for the current OS the user is running:

<https://www.st.com/en/development-tools/stm32cubeprog.html>

5.1.1. Start Smart Devices App on Windows

Go to the Smart Devices App folder and click on the file **SmartDevicesApp.bat**.

5.1.2. Start Smart Devices App on GNU/Linux

Open a new terminal window and navigate to the folder containing the Smart Devices App application, then type:

```
sudo ./SmartDevicesApp.sh
```

5.1.3. Start Smart Devices App on MacOSX

Open a new terminal window and navigate to the folder containing the Smart Devices App application, then type:

```
sudo ./SmartDevicesApp.sh
```

5.2. Upgrading the Smart Devices App

Occasionally, some improvements and new services will be released; if this is the case, the Smart Devices App will show a notification encouraging the user to go to the "Installation" section and download the new version.

Important:

It is mandatory to have an active internet connection in order to use the Smart Devices App .

To upgrade the Smart Devices App , you must follow the installation steps. This will overwrite the files from previous versions. As a 1st step, we recommend to backup the following files:

- **cfg/config.ini:** This file stores the Smart Devices App configuration parameters. To restore those settings, every single parameter value (username, password, etc) should be copied into the new version of the "config.ini" file. The file should not be overwritten, new parameters must be added and merging files is mandatory.
- **temp:** This folder contains the firmware files previously used. To restore these files, copy the content of the saved "temp" directory into the new version "temp" directory.



Figure : Smart Devices App files

5.3. Smart Parking v2

There is a new tab on the application for the new Parking version section called "Smart Parking v2 ". Inside the tab there are a lot of new characteristics and options to configure the Smart Parking v2 device.

The main sections are: Programmer, Firmware Update and Configuration.

5.3.1. 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.

Note: Go to the “[User switches](#)” section for further information

Important:

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.

5.3.2. Configuration

In the last tab, called **Configuration**, 2 parameters are available: “Username” and “Password”. These are the same credentials needed for the Libelium Cloud (SCM, <https://cloud.libelium.com/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 : Configuration screen on Smart Parking v2

There are some differences between the 1st version and the 2nd one. In Smart Parking v2 you must type your credentials to authenticate your nodes against the SCM.

Note: You should have an account on the SCM to get your username and password.

If you forgot your password you can always recover it by clicking on the “Forgot password?” link on the application:

<https://cloud.libelium.com/password/reset>

5.3.3. Programmer (change node parameters)

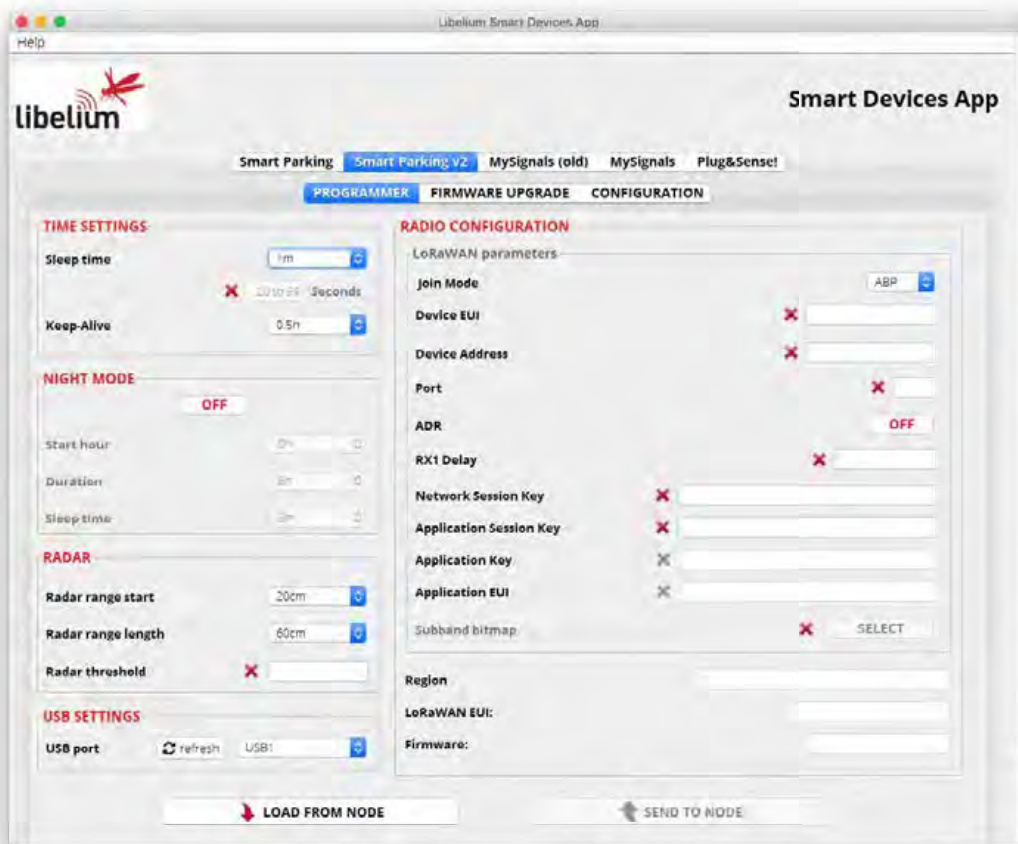


Figure : Smart Parking v2 Programmer section

Users can read and write all node parameters in this section. The process is quite simple: just connect the device to the computer where the Smart Devices App 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 Smart Parking v2 device.

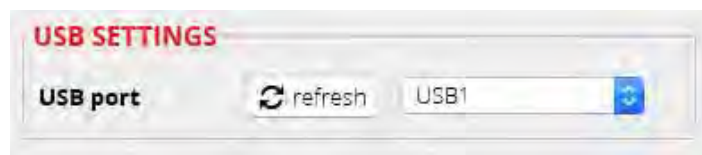


Figure : Smart Parking v2 USB settings

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 like this ✗ 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 : "Load configuration from node" & "Send configuration to node" buttons

Smart Parking v2 shares most of the configuration fields with Smart Parking v1 . However, it is important to know the purpose for each field on the Smart Parking v2 configuration. To know more about each field and how they work, please refer to the chapter "[Smart Parking node](#)".

5.3.4. Firmware upgrade

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

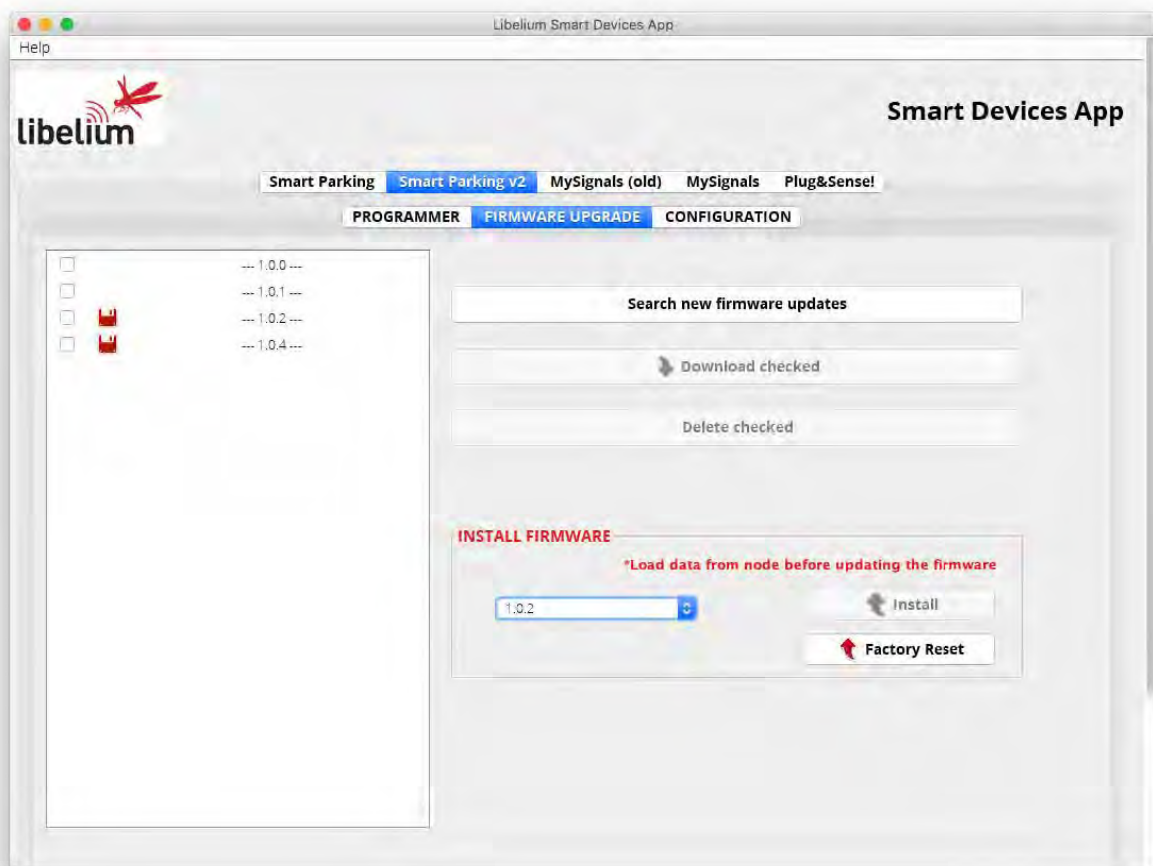


Figure : Firmware update and factory reset section for Smart Parking v2

The list with all available firmwares 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**".

Important:

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


To summarize, the steps are:

1. Click the “Search new firmware updates” button to load new firmware updates
2. Check one or more firmwares to download from the firmware list on the left side
3. Click on “Download checked” to download the selected firmwares



Figure : 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.

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

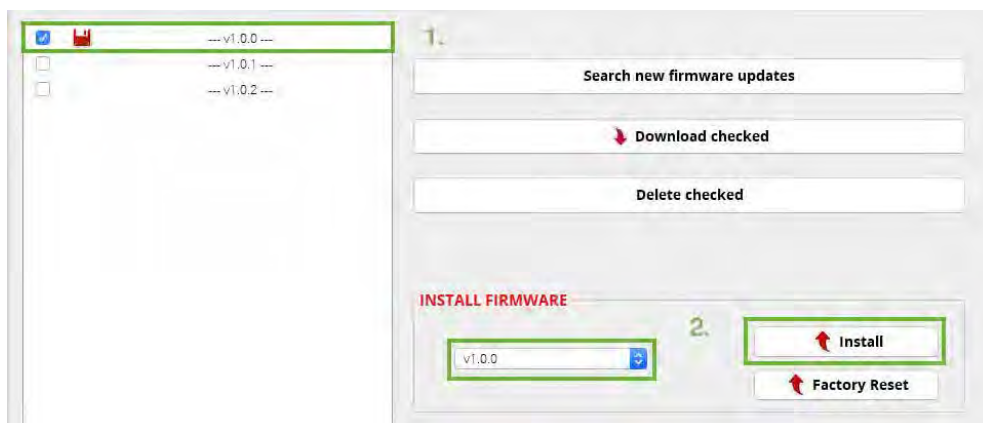


Figure : Firmware installation

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

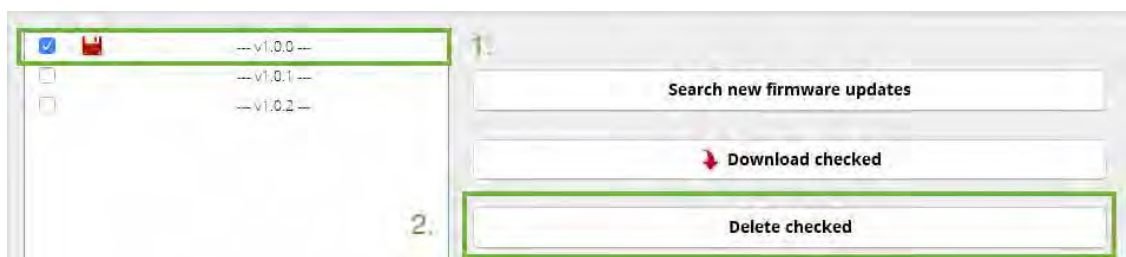


Figure : Firmware deletion process for Smart Parking v2

5.3.5. Factory Reset

The Factory Reset is the last option to recover a non-working SmartParking 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 tech@libelium.com pointing your Smart Parking v2 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 : Factory reset process for Smart Parking v2 - Step 1

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.

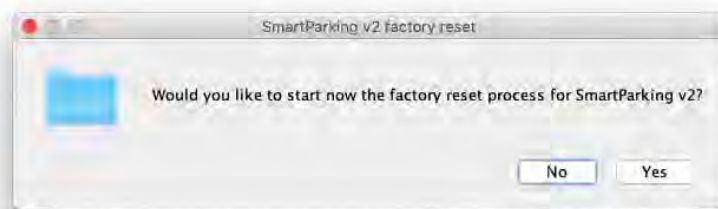


Figure : Factory reset process for Smart Parking v2 - Step 2

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



Figure : Factory reset finished for Smart Parking v2

After this process, you can configure your Smart Parking v2 node again on the "Programmer" tab.

6. LoRaWAN Network Server setup

Libelium currently supports 5 LoRaWAN Network Server services: Lorient, Actility, The Things Network, The Things Industries and the Embedded Network Server inside MultiTech basestations. In this section, we explain how to set them up with a simple configuration.

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.

6.1. Lorient

This section explains how to route the information on Lorient to the Customer server or to the Smart Parking Cloud Service, using the HTTPS protocol.

Important:

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.

6.1.1. Log in

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

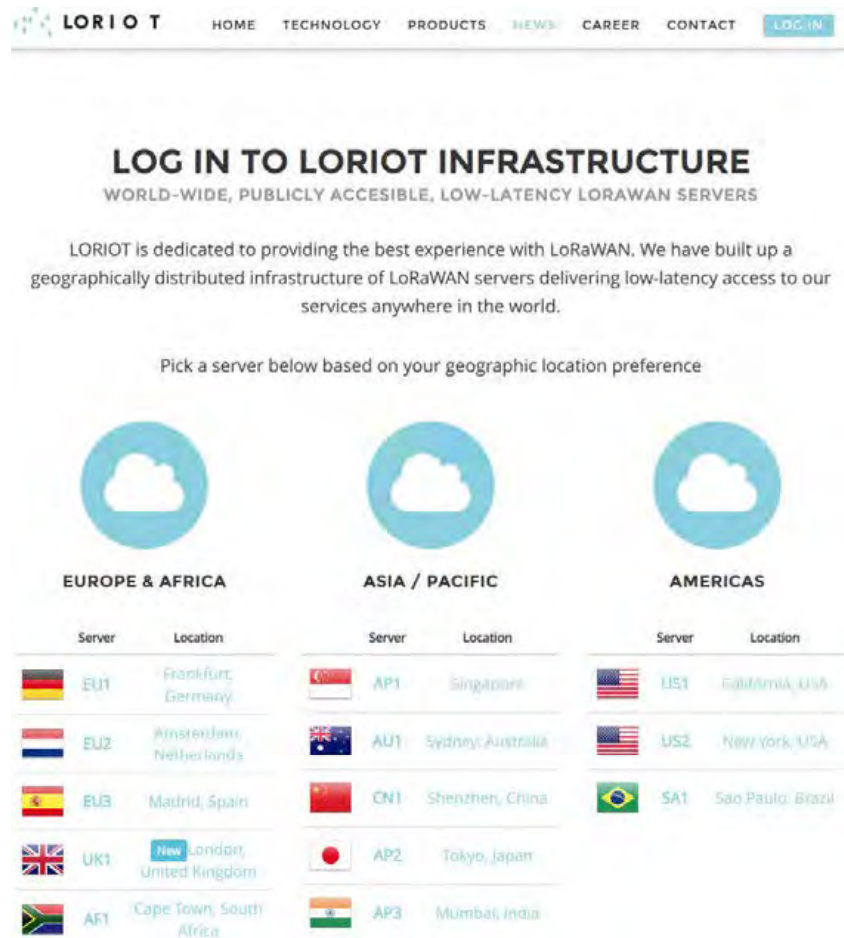


Figure : Loriot login web page

6.1.2. 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 **"Applications"** in the left side bar and then in **"New Application"** option located in the same bar:

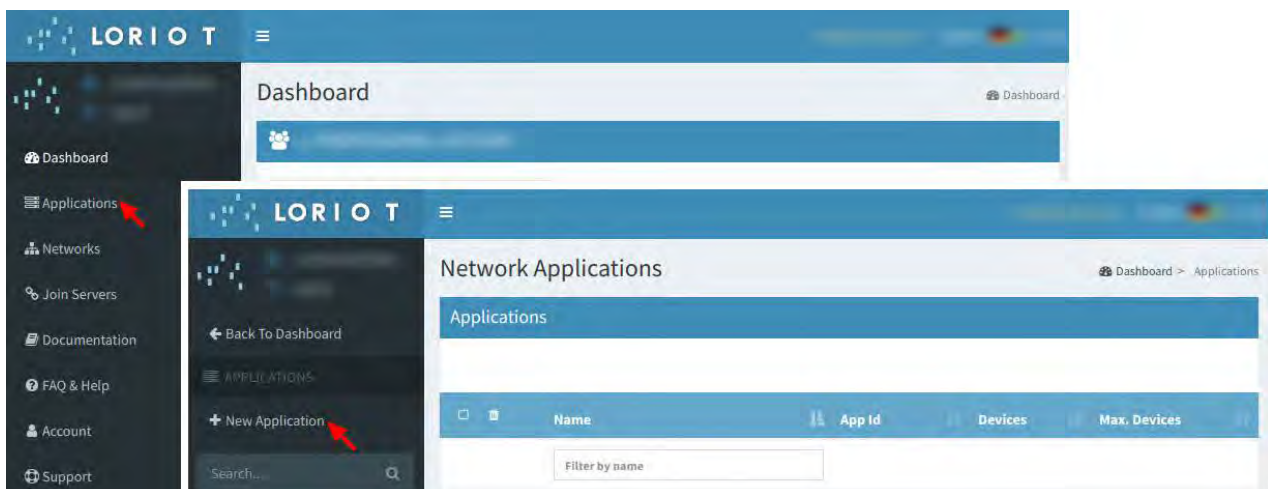
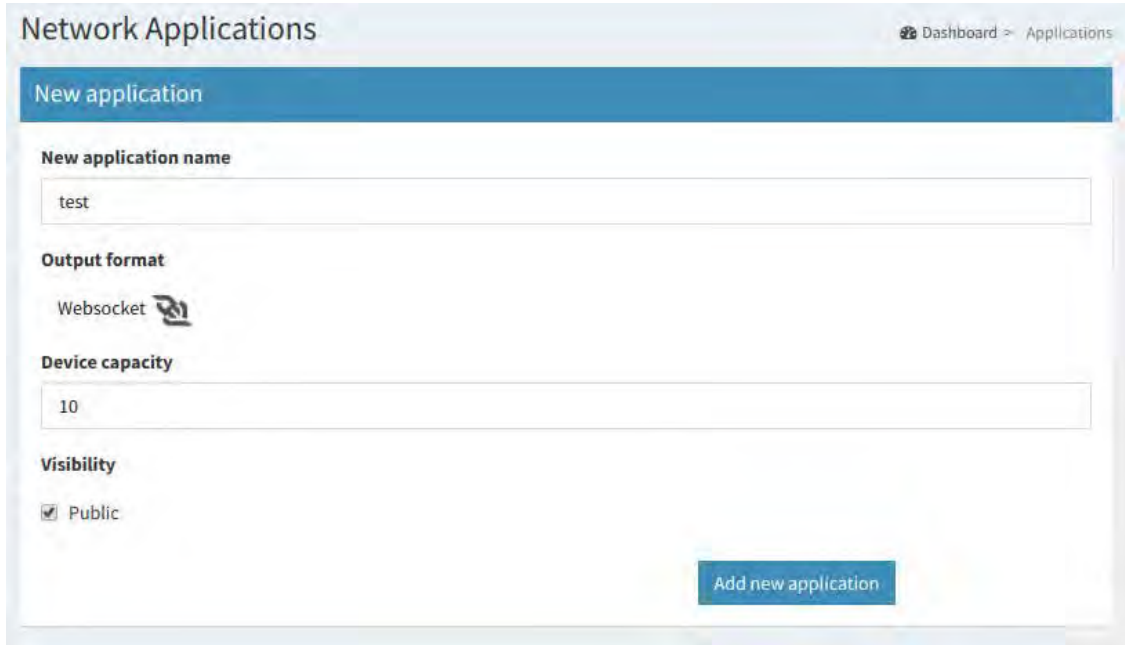


Figure : Creating an application

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".




Network Applications Dashboard > Applications

New application

New application name

test

Output format

Websocket 

Device capacity

10

Visibility

☒ Public

Add new application

Figure : New application form

6.1.3. Manage Lorient output data

Once the application is created, the dashboard will be shown. Go to **"Application Outputs"** → click on **"Manage outputs"** → click on "Add new output":

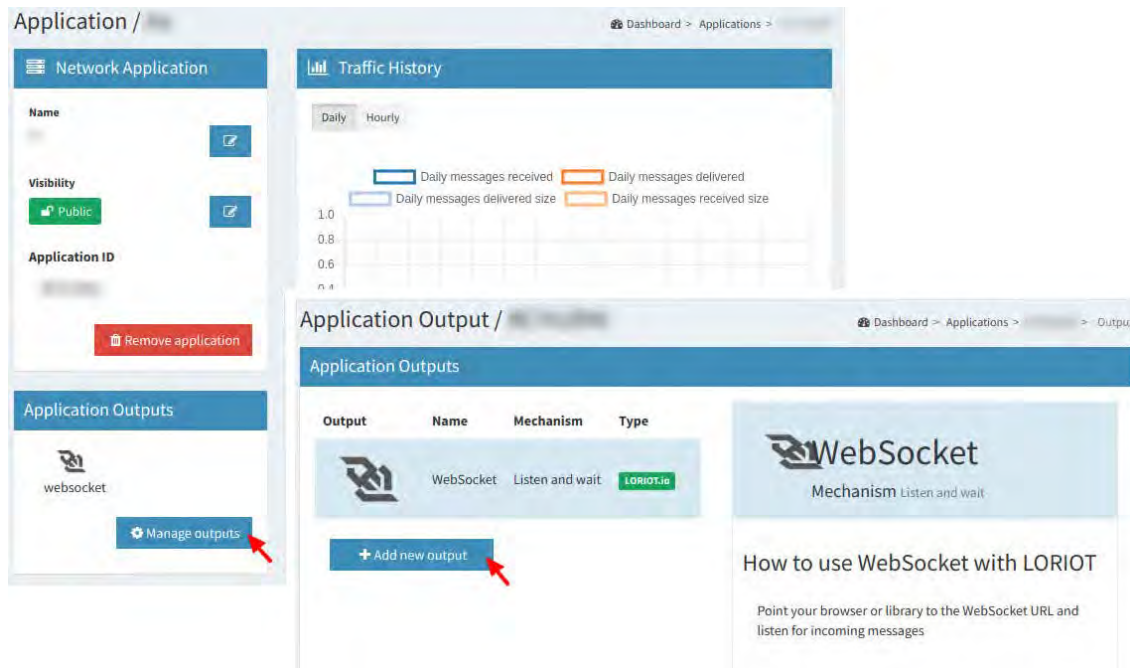


Figure : Create a new application output

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 Lorient must send data to (i.e. `http://my_server.com/services/activity/`). 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.

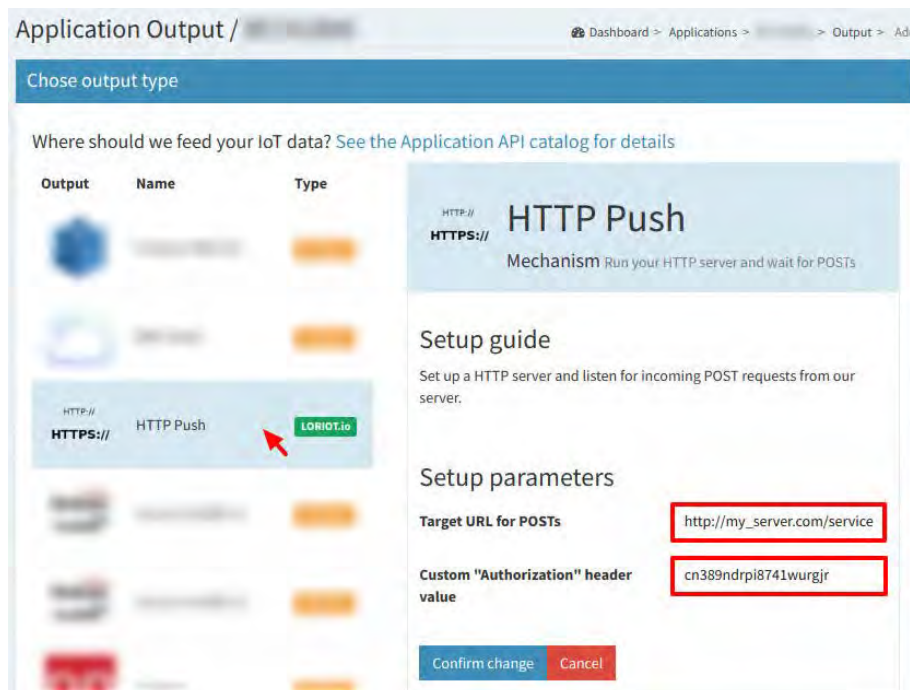


Figure : Application output configuration

6.1.4. How to delete unused Lorient 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.

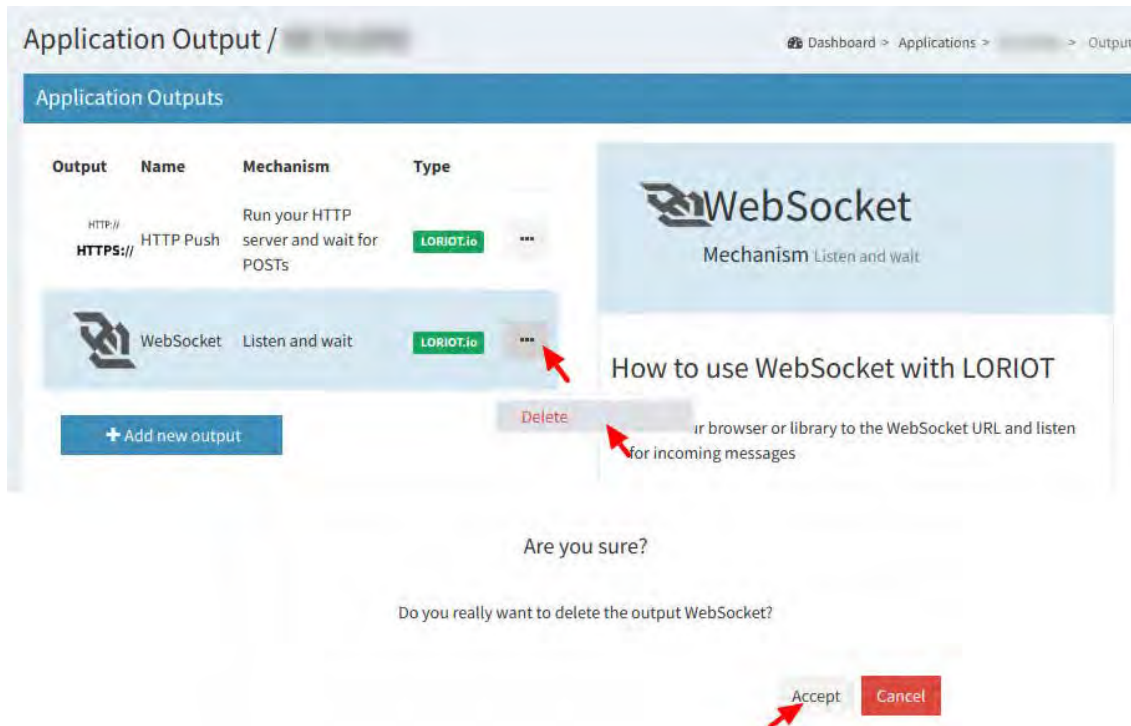


Figure : Delete unused application outputs

6.1.5. 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:

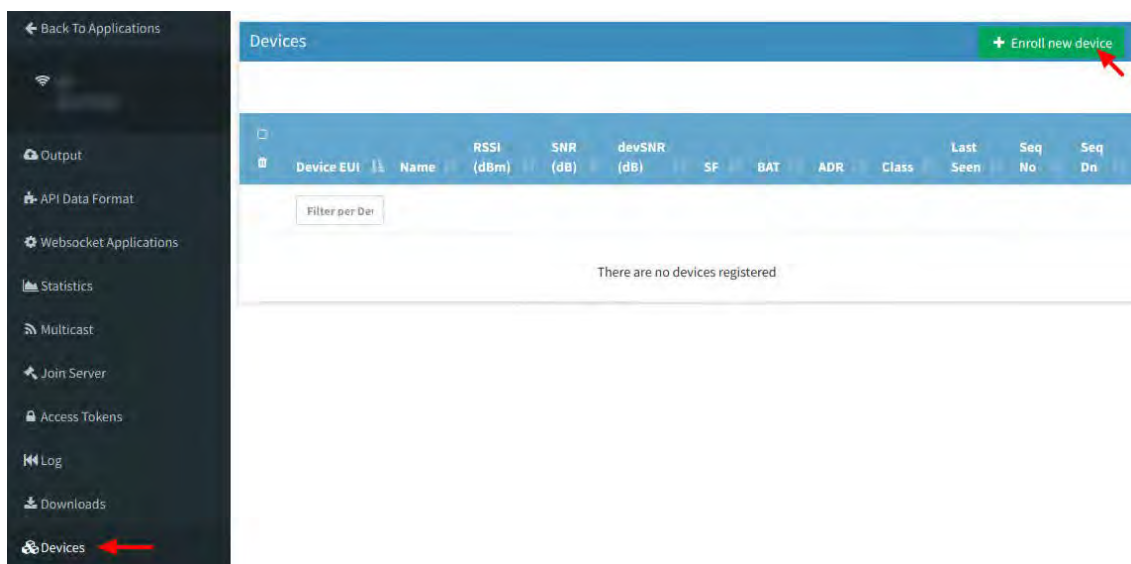


Figure : Enroll new device

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

Device Location

Country


Address

ZIP Code

City

Latitude

Longitude



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

DevAddr (8)

Sequence number uplink

FCntUp (Decim)

Sequence number downlink

FCntDn (Decim)

EUI (optional)

DevEUI (16 hex digi)

Network session key

NWKSKEY (32 hex digits)

Application session key

APPSKEY (32 hex digits)

Description

☐ Create Another

Enroll

Reset

Figure : New device form

6.1.6. Nodes batch provisioning in Lorient

Inside the Lorient 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 management](#)" section for further information on how to export this CSV file which includes all nodes OTAA credentials needed for direct batch import.

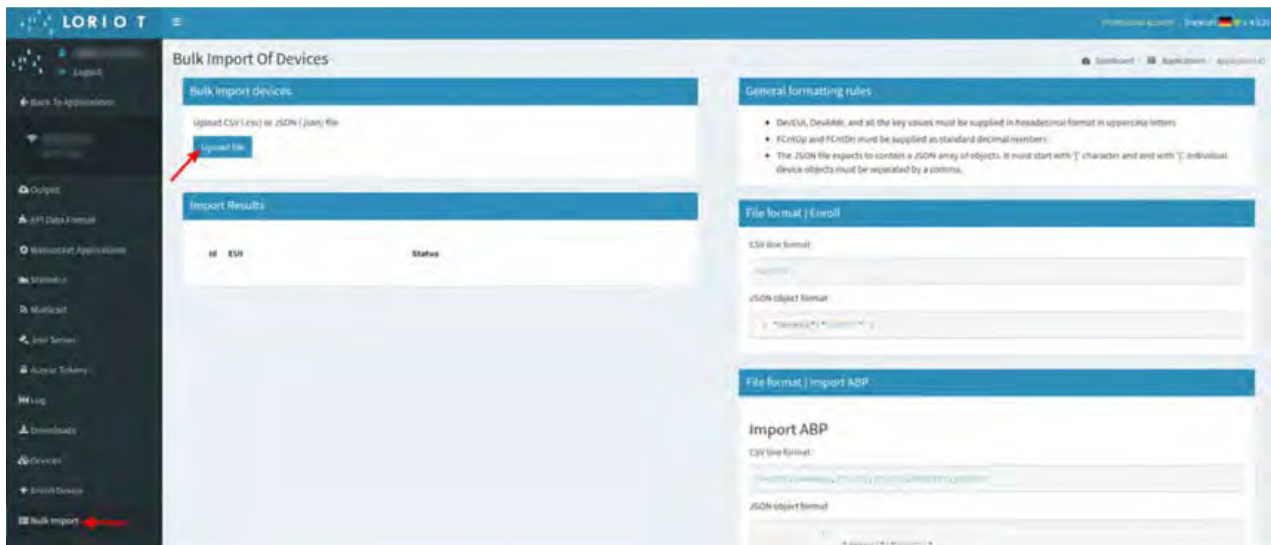


Figure : Lorient bulk import

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>
```

6.2. Activity

This section explains how to route information on Activity to the Customer server or to the Smart Parking Cloud Service, using the HTTPS protocol. Firstly, you must access into the Activity's [ThingPark portal](#) and log in. IN the main portal, you must go to **"ThingPark Application"** section and access to **"Device Manager"**:

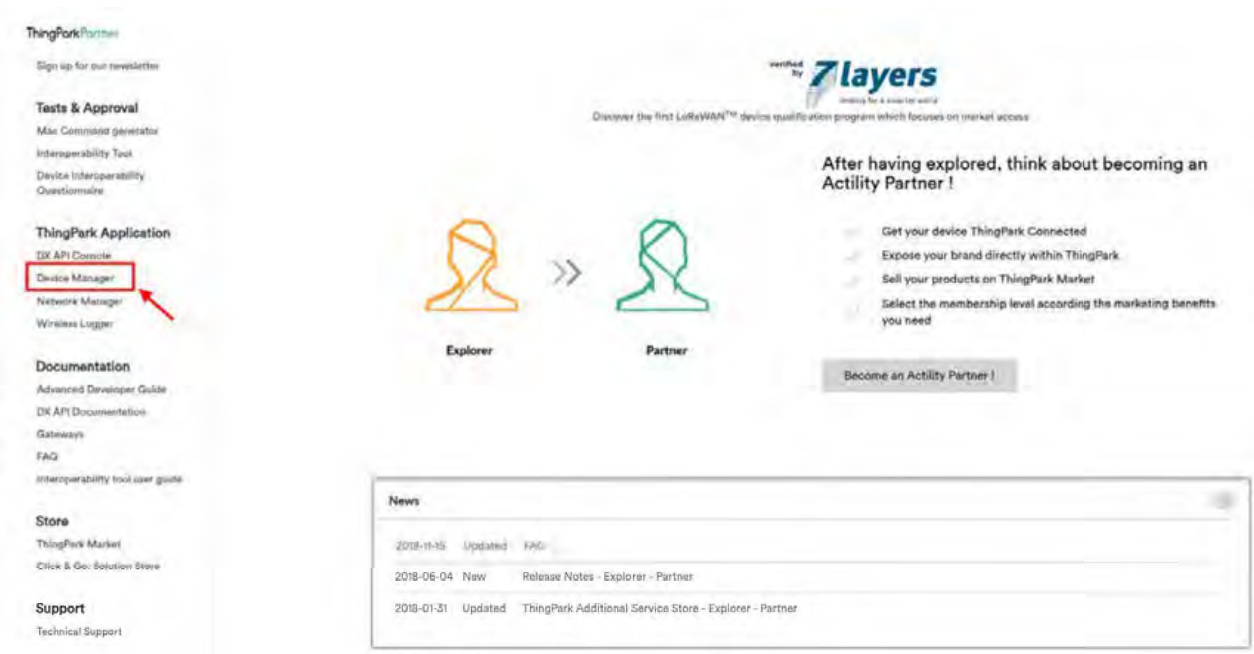


Figure : Access to "Device Manager" menu

Activity requires an "Application Server" and an "AS routing profile" in order to establish the communication with the Customer server or the Smart Parking Cloud Service. These 2 elements are required before starting the service the 1st time, and will be the base to create new devices.

6.2.1. 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 : 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":

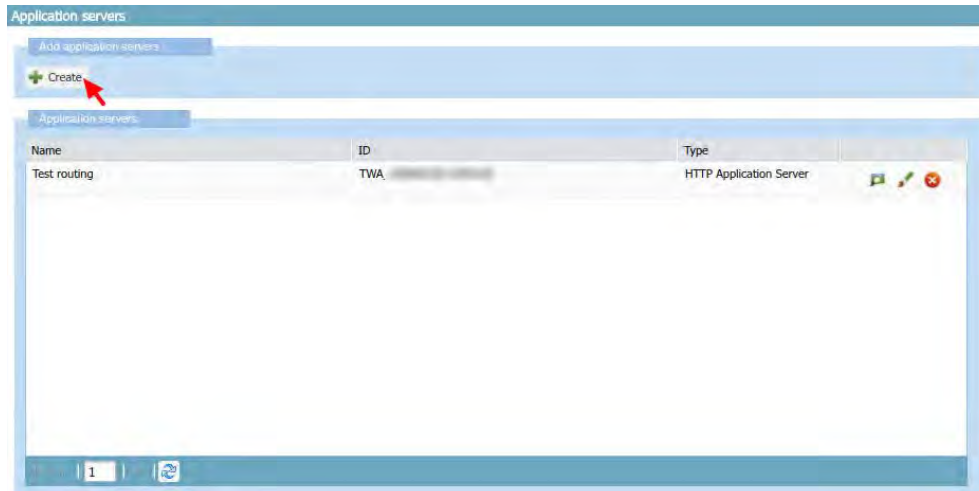


Figure : Application servers menu

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:

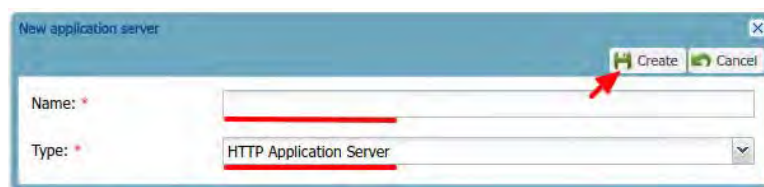


Figure : Application server name

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:

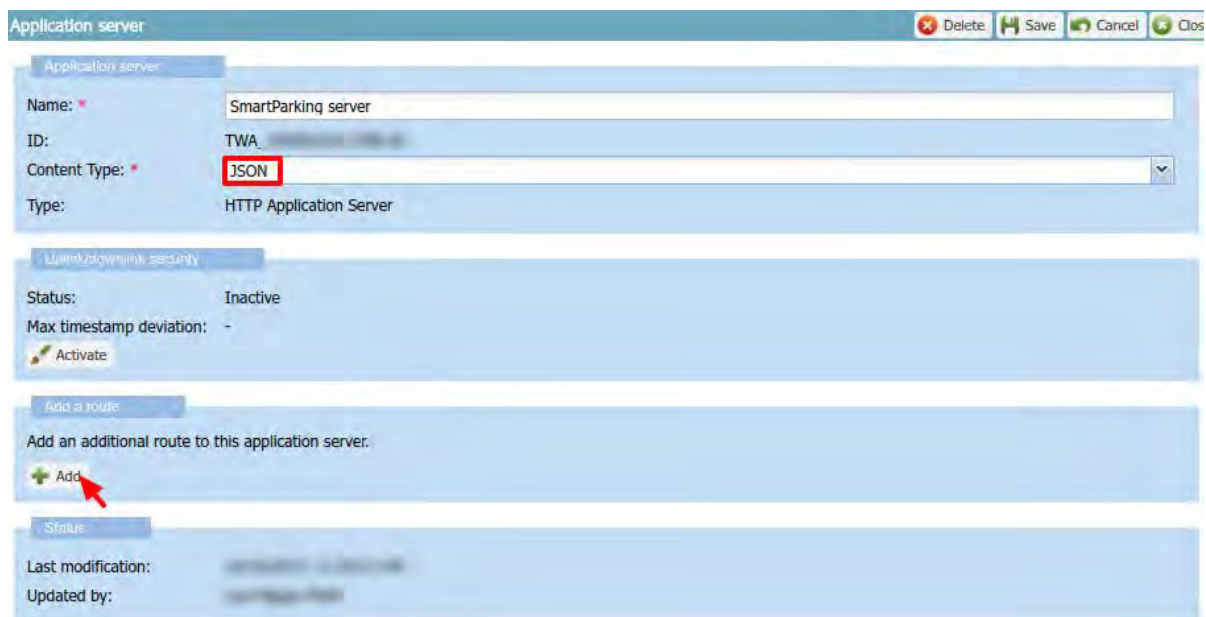


Figure : Application server form

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



Figure : 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. Click on the **"Add"** button to save the information:



Figure : Destination form

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

6.2.2. 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 : 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:

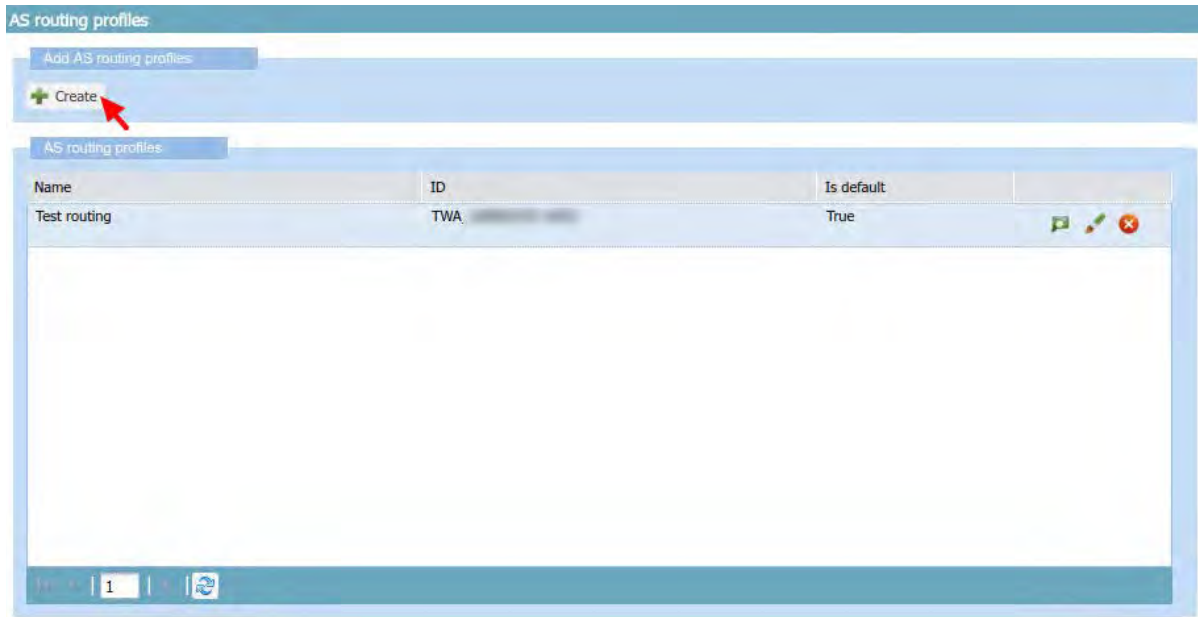


Figure : AS Routing profiles

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:

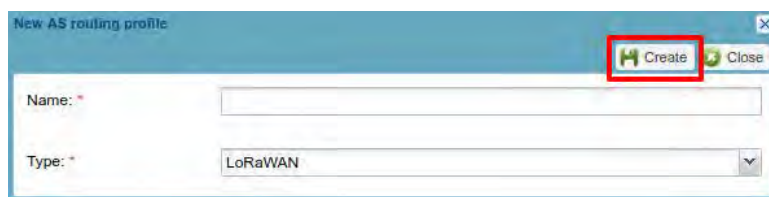


Figure : AS Routing profile name

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"**:

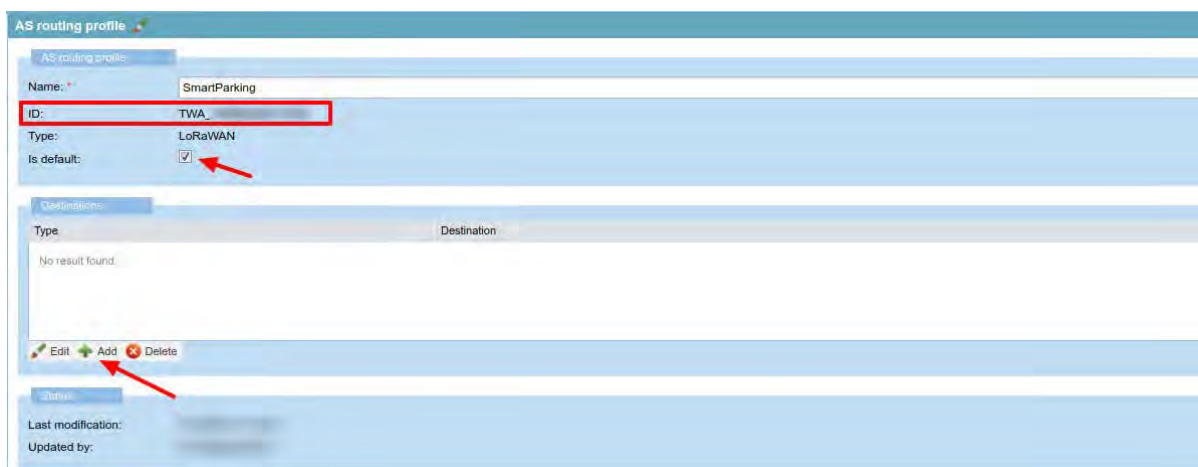


Figure : AS Routing profile route

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:

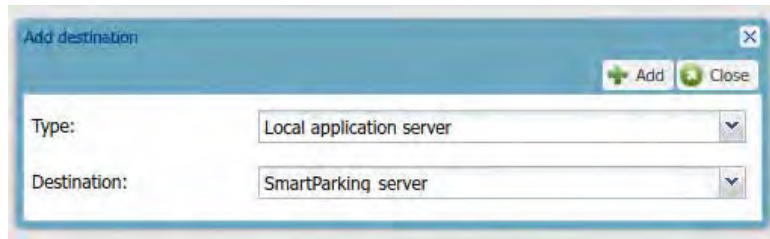


Figure : Add the created Application server as "destination" for the routing profile

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.

6.2.3. 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:

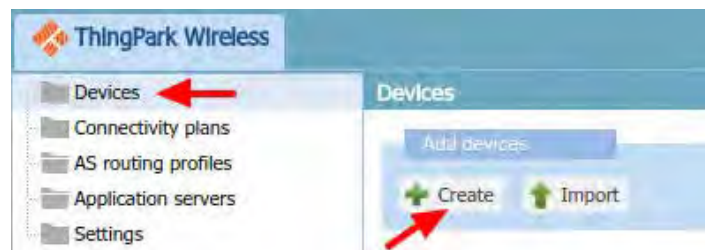


Figure : Create new devices

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_ETSI_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.

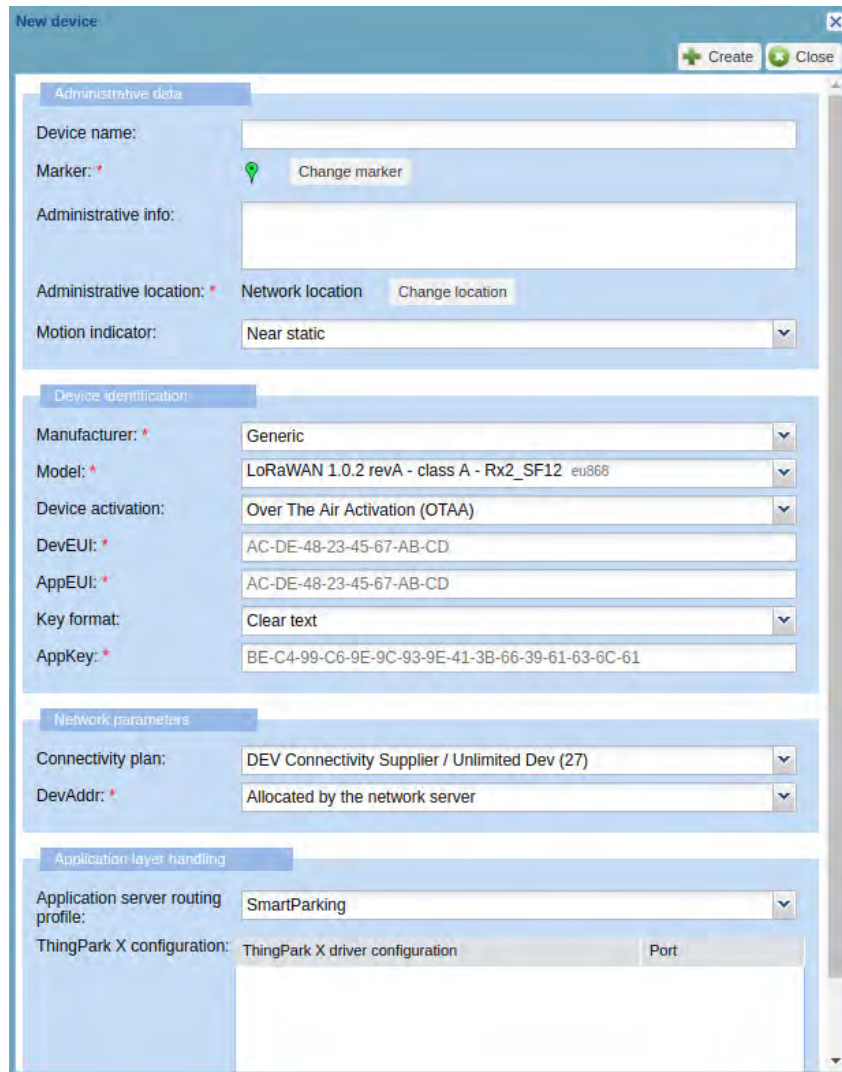


Figure : Enter all device's parameters

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

6.2.4. Nodes batch provisioning in Actility

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

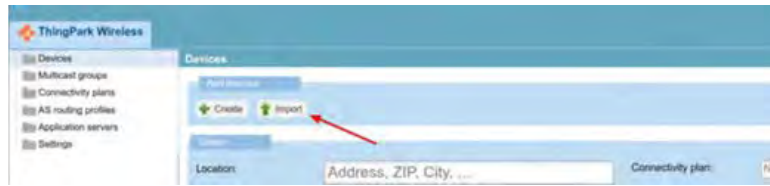


Figure : Import devices

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

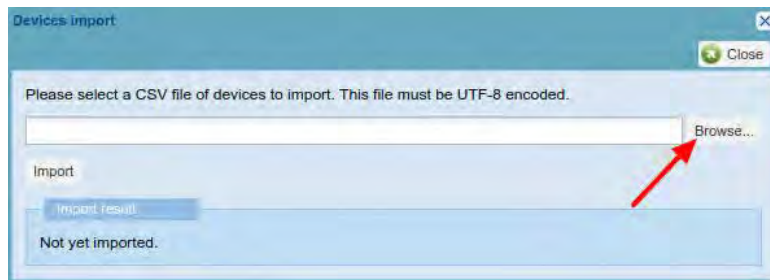


Figure : Import CSV file

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,<DevEUI_1>,<DevProfile>,<AppEUI_1>,<AppKey_1>,<AS_profile_ID>,<ConnectivityPlan>,<name>,,,,,
CREATE_OTAA,<DevEUI_2>,<DevProfile>,<AppEUI_2>,<AppKey_2>,<AS_profile_ID>,<ConnectivityPlan>,<name>,,,,,
CREATE_OTAA,<DevEUI_3>,<DevProfile>,<AppEUI_3>,<AppKey_3>,<AS_profile_ID>,<ConnectivityPlan>,<name>,,,,,
...
CREATE_OTAA,<DevEUI_N>,<DevProfile>,<AppEUI_N>,<AppKey_N>,<AS_profile_ID>,<ConnectivityPlan>,<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_ETSI_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.
- **<ConnectivityPlan>:** 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:

```
CREATE_OTAA,<EUI1>,,LORA/GenericA.1.0.2a_ETSI_Rx2-SF12,<AppEUI1>,<AppKey1>,,dev-cs/testing,TWA_123,,Node1,,,,,
CREATE_OTAA,<EUI2>,,LORA/GenericA.1.0.2a_ETSI_Rx2-SF12,<AppEUI2>,<AppKey2>,,dev-cs/testing,TWA_123,,Node2,,,,,
CREATE_OTAA,<EUI3>,,LORA/GenericA.1.0.2a_ETSI_Rx2-SF12,<AppEUI3>,<AppKey3>,,dev-cs/testing,TWA_123,,Node3,,,,,
CREATE_OTAA,<EUI4>,,LORA/GenericA.1.0.2a_ETSI_Rx2-SF12,<AppEUI4>,<AppKey4>,,dev-cs/testing,TWA_123,,Node4,,,,,
CREATE_OTAA,<EUI5>,,LORA/GenericA.1.0.2a_ETSI_Rx2-SF12,<AppEUI5>,<AppKey5>,,dev-cs/testing,TWA_123,,Node5,,,,,
```

6.3. The Things Network (TTN)

This section explains how to route information on TTN to the Customer Server or to the Smart Parking Cloud Service, using the HTTP protocol. TTN is a free and ready to use Network Server on the cloud for LoRaWAN communications. TTN gives the user a wide variety of integrations ready to use.

6.3.1. Log in

Open a new window on your web browser and type: <https://www.thethingsnetwork.org/>

Login or create a new user account if you do not have one yet:

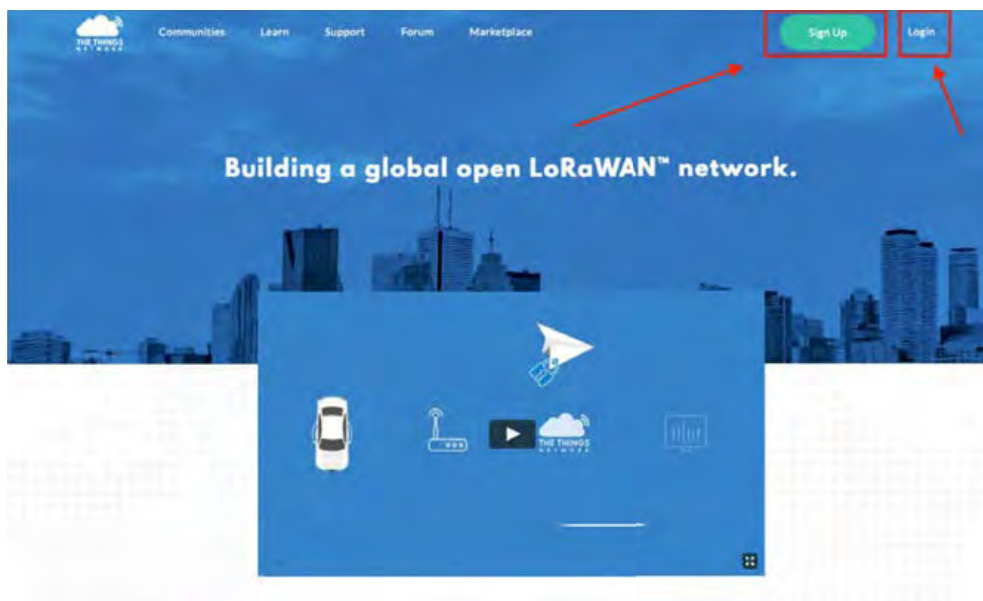


Figure : Create account or login on TTN

Then enter your credentials:

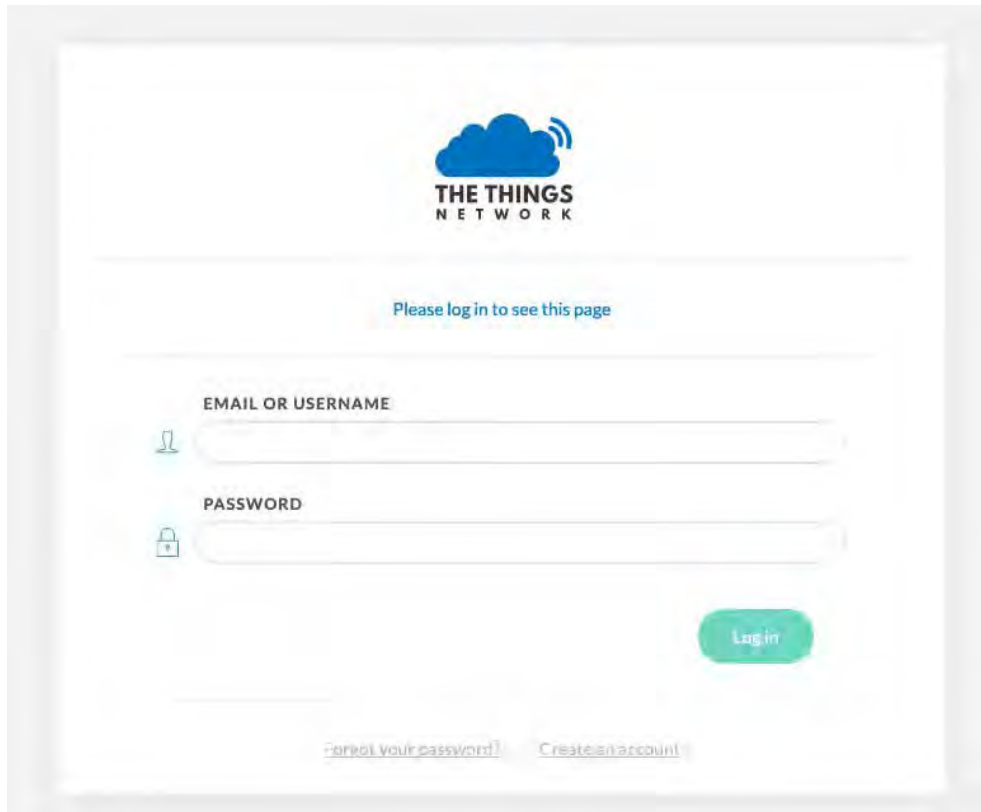


Figure : Login credentials on TTN

After a successful login, the main panel will be shown. From this screen the user can access different sections to manage her devices and view data:

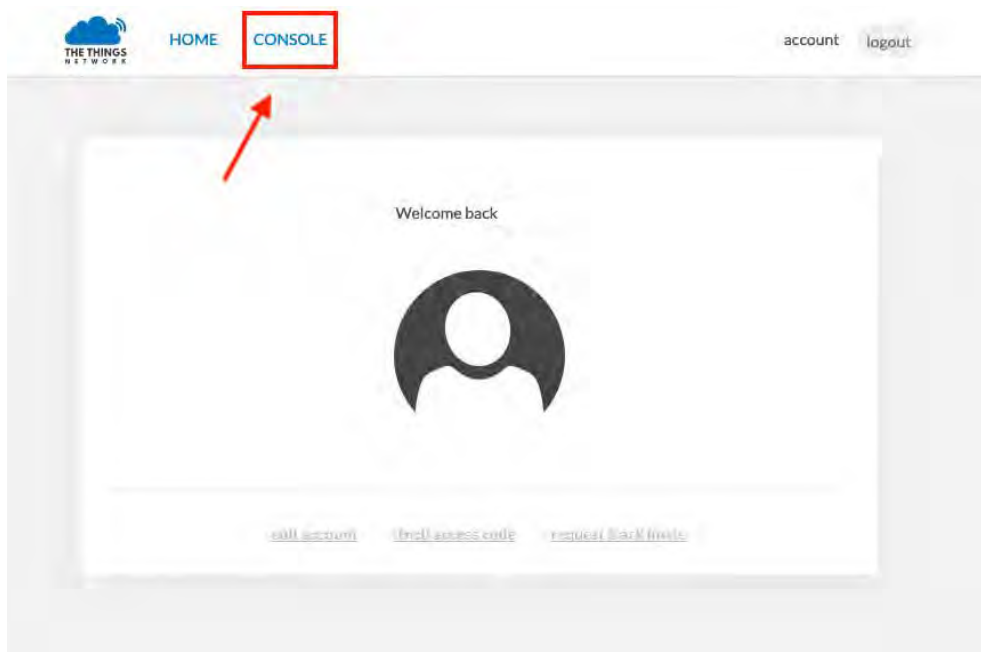


Figure : Main screen on TTN

Click on "Console" to open the 2 main sections on TTN: one for applications and one for gateways.

6.3.2. Manage gateways

Select "Gateways" to manage your devices. You can see a list of them (if you already created some gateways) or you can create a new gateway device:

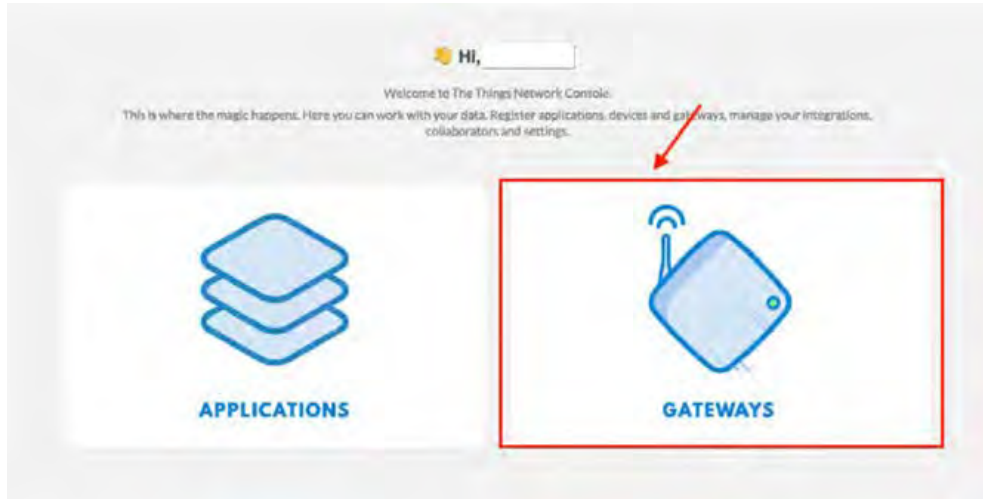


Figure : Main sections on TTN - Gateways

Register a new gateway

To register a new gateway, click on "Register gateway". A new form is displayed:

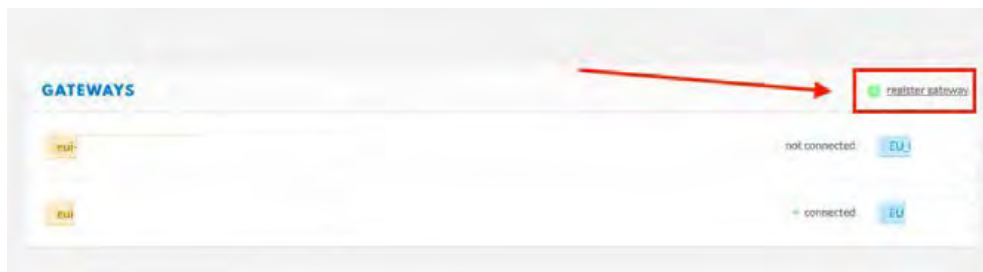


Figure : Create new gateway on TTN

On the gateway form, enter the following data to create a new one:

1. Gateway ID: A unique and human-readable identifier for the gateway.
2. Description: The gateway description.
3. Frequency Plan: This parameter belongs to each country regulation, for more information please visit [this link](#).
4. Router: Select the gateway to connect, choose the closest one to your location to get a better coverage.
5. Location: Set the location on the map.
6. Antenna Placement: Choose between indoor or outdoor.

Gateways **Register**

REGISTER GATEWAY

Gateway ID
A unique, human-readable identifier for your gateway. It can be anything so be creative!

☐ **I'm using the legacy packet forwarder**
Select this if you are using the legacy [Semtech packet forwarder](#).

Description
A human-readable description of the gateway

Frequency Plan
The frequency plan this gateway will use

no selection

Router
The router this gateway will connect to. To reduce latency, pick a router that is in a region which is close to the location of the gateway.

Figure : Create new gateway on TTN - Step 1

Location
The exact location of your gateway. This will be used if your gateway cannot determine its location by itself. Set a location by clicking on the map.

Antenna Placement
The placement of the gateway antenna

Indoor outdoor

Cancel Register Gateway

Figure : Create new gateway on TTN - Step 2

After filling all the fields, press "Register gateway" to confirm this new device.

Gateway settings

By clicking on the new created gateway, a new screen summarizing the information will appear. The user can edit the gateway information, change the settings, delete the registered gateway and see the traffic on the gateway.



Figure : Summarized information and edit settings on TTN

An important option for the gateway is present on "Settings": at the bottom of the page there is a red button called "Delete gateway eui-XXX". This is used to perform a full deletion of the gateway. Do not click this option if you want to preserve your gateway as registered.

6.3.3. Manage applications

The "Applications" section permits to view, edit and create applications, as well as view data and integrate it with other clouds.

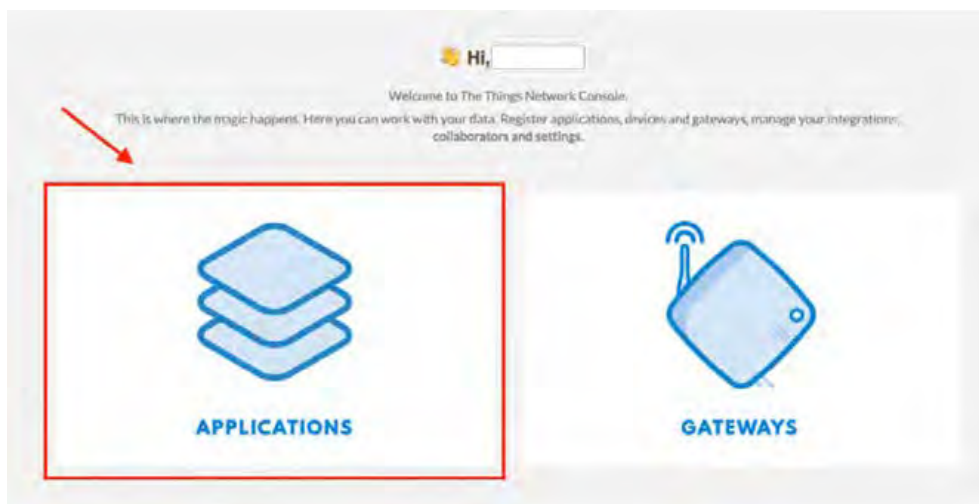


Figure : Main sections on TTN - Applications

After clicking on "Applications", a list of them will appear if the user has already created applications.

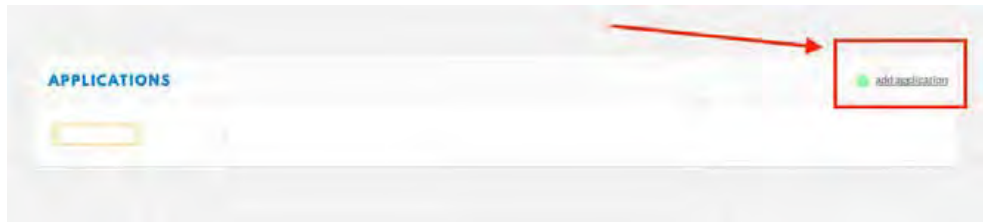


Figure : List of applications on TTN

On the top right corner there is an "Add application" button to register a new application, click on this option to create a new one. Fill all the information and press "Add application" to confirm the data:

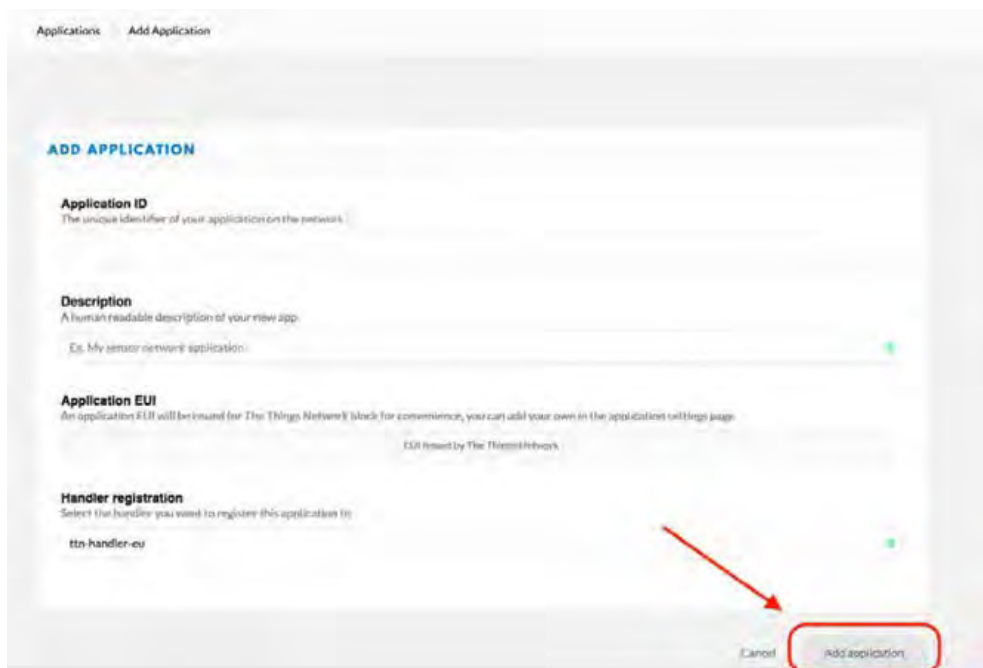


Figure : Add new application on TTN

Options and device registration overview

There are plenty of options to configure an application. This guide will guide you through the most important options to accomplish the integration with the Customer Server or with the Smart Parking Cloud Service.

The main screen shows a summary about the application, the registered devices and the access key (important for the Integrations section):

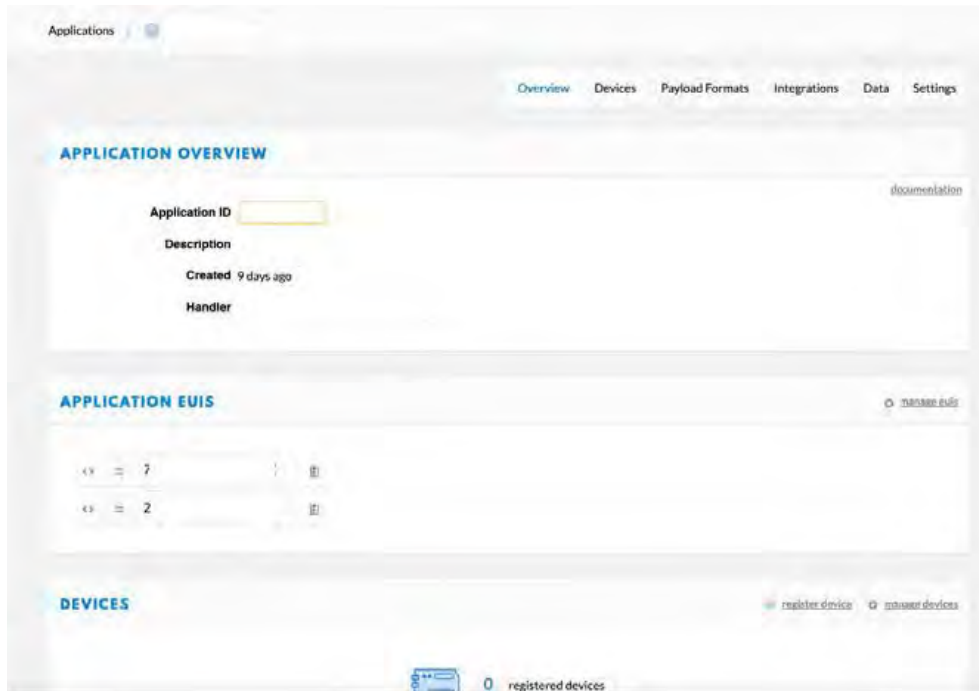


Figure : Application overview on TTN

On the top right area of the "Devices" section it is possible to register a new device for the application. Creating a new device is not required to perform the integration with the Customer Server or with the Smart Parking Cloud Service.

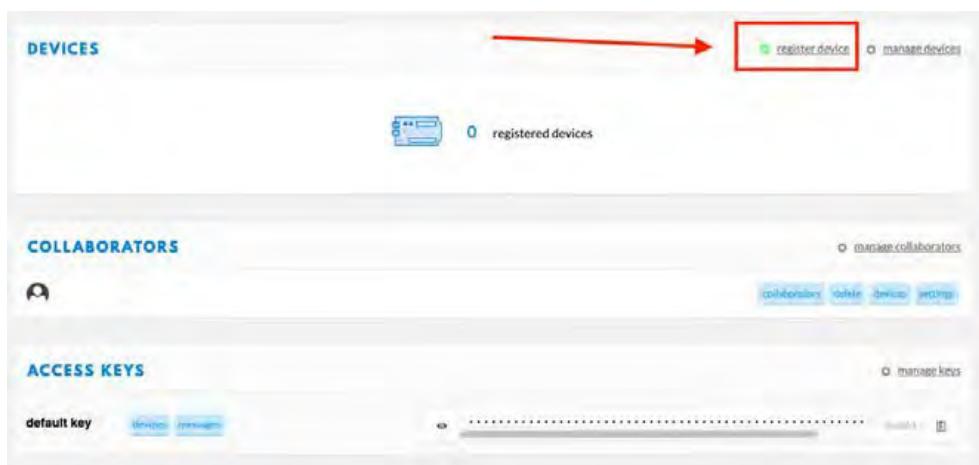


Figure : Registering a new device for an application on TTN

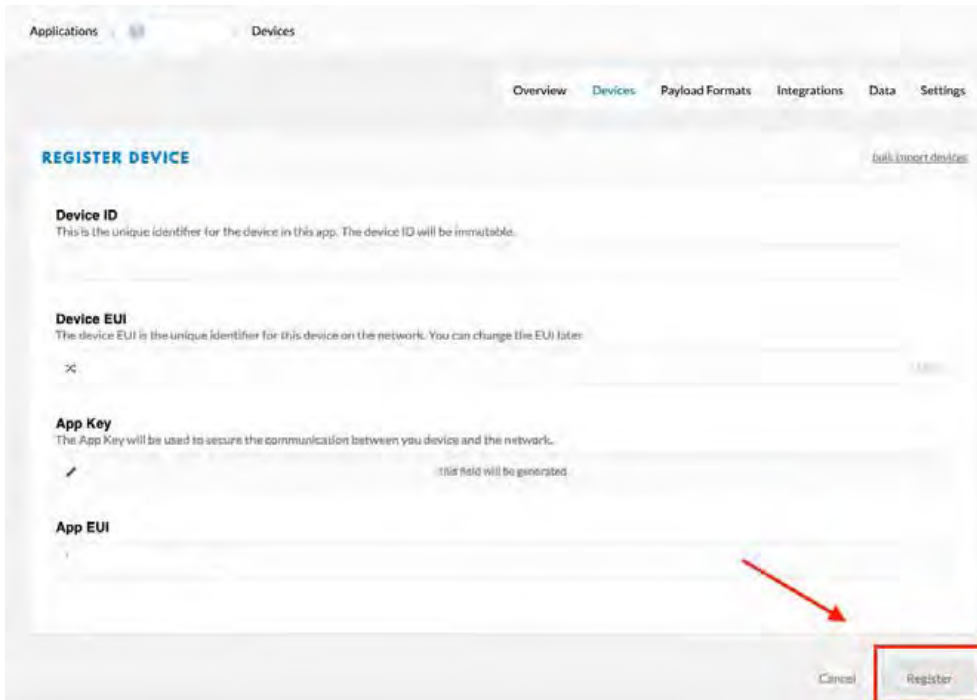
To create a new device, fill all the fields:

- Device ID: The unique identifier for the device in the application.
- Device EUI: The unique identifier for the device on the network.
- App Key: Used to create a secure communication between the device and the network.

Important:

The Device ID must be the same as LoRaWAN EUI in lowercase to match the communication with the Customer Server or with the Smart Parking Cloud Service.

After setting these fields, hit the "Register" button to finish the registration.



Applications | **Devices**

Overview | **Devices** | Payload Formats | Integrations | Data | Settings

REGISTER DEVICE [bulk import devices](#)

Device ID
This is the unique identifier for the device in this app. The device ID will be immutable.

Device EUI
The device EUI is the unique identifier for this device on the network. You can change the EUI later.

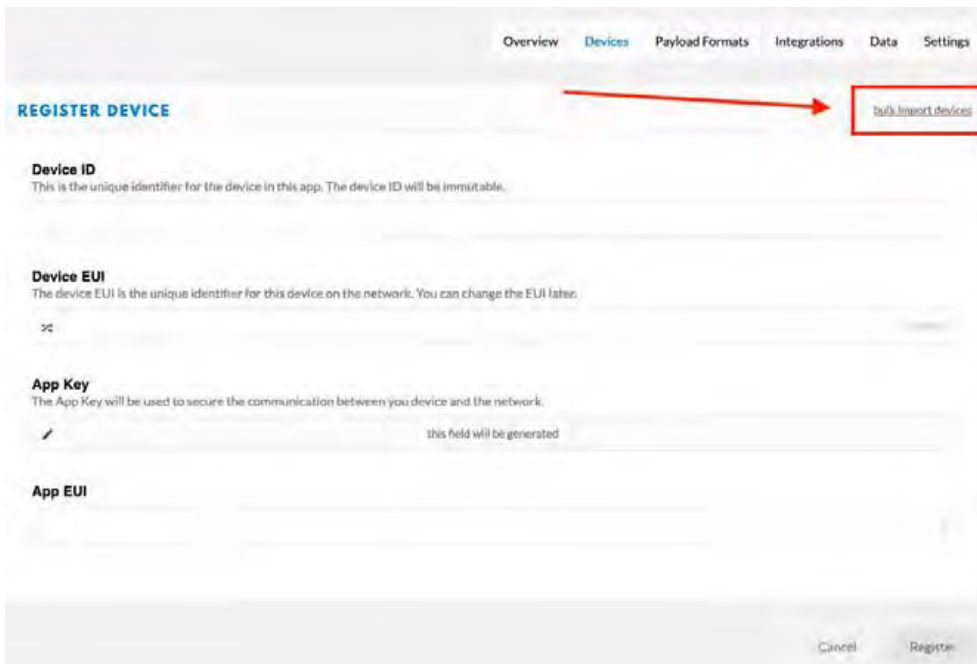
App Key
The App Key will be used to secure the communication between you device and the network.

App EUI

Cancel Register

Figure : Form to create a new device on TTN

There is also a chance to register more that one device in bulk using the "Bulk import devices" button placed on the top right:



Overview | **Devices** | Payload Formats | Integrations | Data | Settings

REGISTER DEVICE [bulk import devices](#)

Device ID
This is the unique identifier for the device in this app. The device ID will be immutable.

Device EUI
The device EUI is the unique identifier for this device on the network. You can change the EUI later.

App Key
The App Key will be used to secure the communication between you device and the network.

App EUI

Cancel Register

Figure : Bulk devices import on TTN

The screen for a bulk import is very simple:

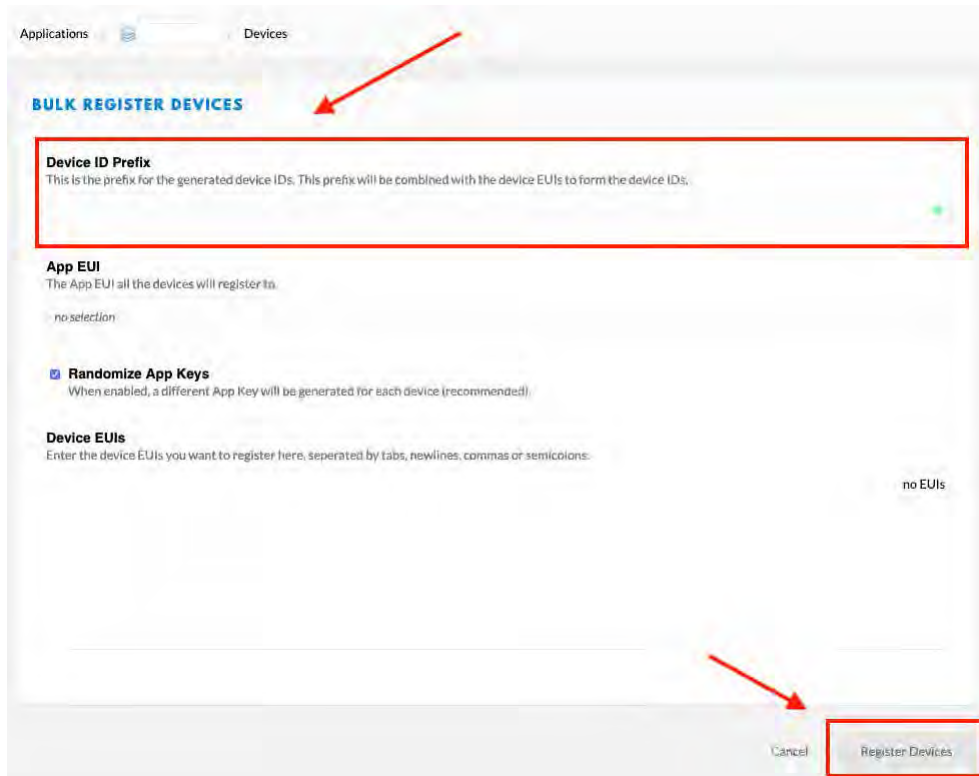


Figure : Bulk devices import form on TTN

The parameters to fill are:

- Device ID Prefix: This is the prefix for the generated device IDs.
- App EUI: The App EUI all the devices will register to.
- Randomize Keys: If enabled, a different App Key will be generated for each device (recommended).
- Device EUIs: The device EUIs to register, separated by tabs, newlines, commas or semicolons.

Important:

The Device ID Prefix must be left in blank to match the communication with the Customer Server or with the Smart Parking Cloud Service.

After entering all the parameters, press "Register devices" to finish the bulk registration process.

Important:

With this kind of bulk import, after creating the devices the user must reconfigure the settings of each node using the App EUI, the App Key and the Device EUI supplied on the registering process.

This new reprogramming process is a result of TTN frontend limitations on registering devices.

Application integrations

Another important section for each application is the "Integrations" section. There the user can send data to third-party clouds and also to the Customer Server or to the Smart Parking Cloud Service.

Click on "Add integration" to create a new mechanism to send data:

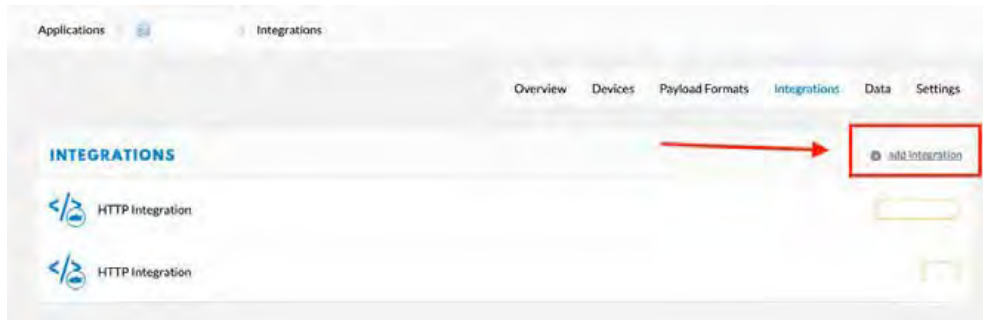


Figure : Integrations screen on TTN

After clicking "Add integration", a list of third-party clouds will be displayed, choose "HTTP integration" to configure TTN to send towards the Customer Server or the Smart Parking Cloud Service:

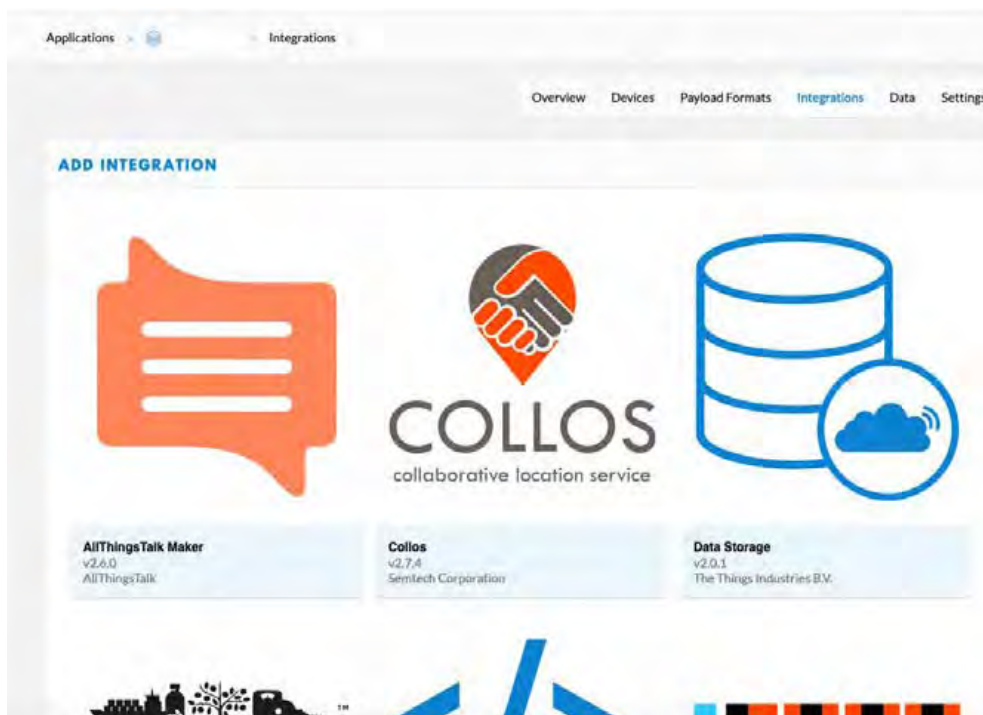


Figure : Integrations list on TTN

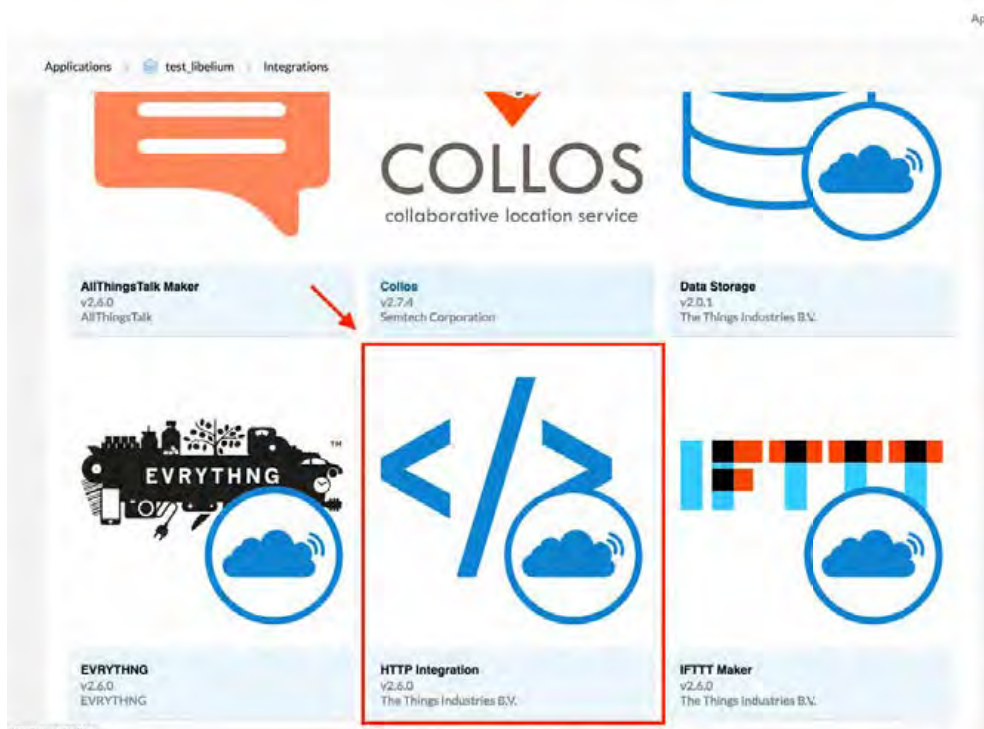
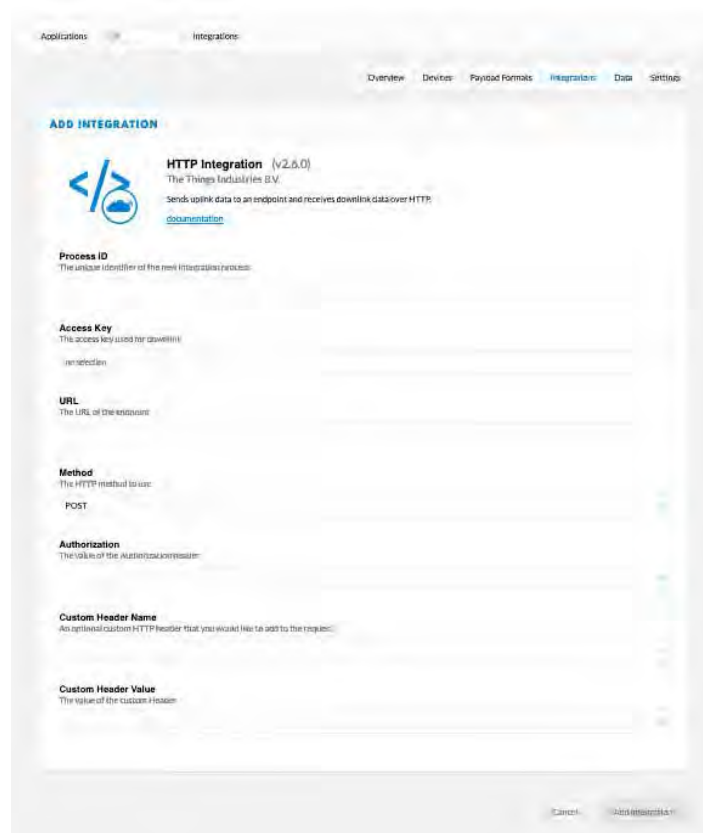


Figure : HTTP integration option on TTN

The form for HTTP connection is as follows:



ADD INTEGRATION

HTTP Integration (v2.6.0)
The Things Industries B.V.
Sends uplink data to an endpoint and receives downlink data over HTTP.
[documentation](#)

Process ID
The unique identifier of the new integration process.

Access Key
This access key is used for downlink.
[text input]

URL
The URL of the endpoint.
[text input]

Method
The HTTP method to use:
POST

Authorization
The value of the authorization header.
[text input]

Custom Header Name
An optional custom HTTP header that you would like to add to the request.
[text input]

Custom Header Value
The value of the custom header.
[text input]

Cancel **Save Integration**

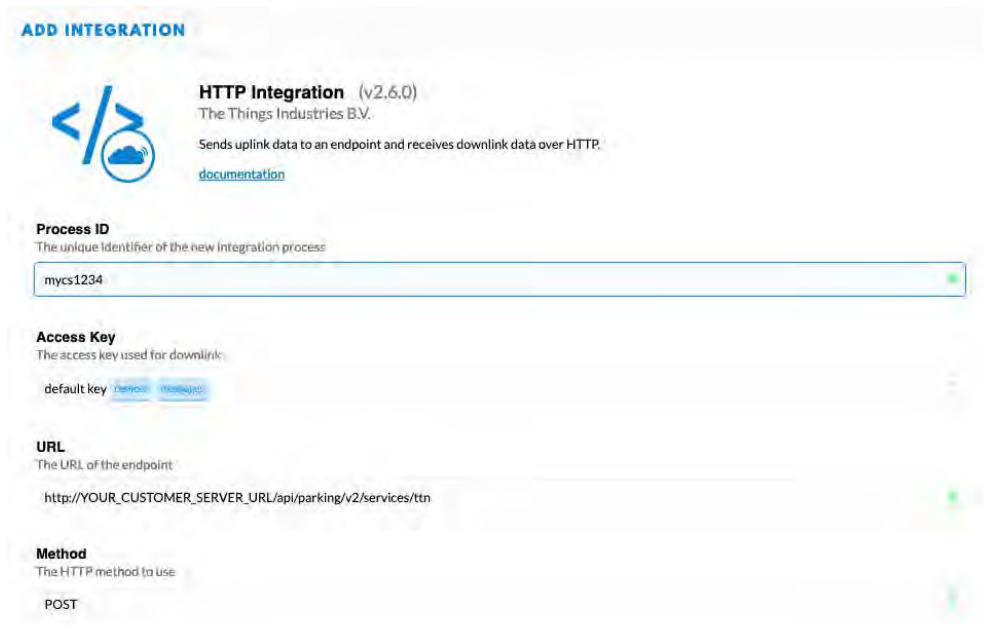
Figure : HTTP integration form on TTN

There are some fields to fill on the form:

- Process ID: The unique identifier of the new integration process. Free text.

- Access Key: The access key used for downlink. It is the default key in most cases.
- URL: The Customer Server URL: `https://YOUR_CUSTOMER_SERVER_URL/api/parking/v2/services/ttn`.
- Method: The HTTP method to use. For Customer Server integration, it must be "POST".

An example of configuration integration for Customer Server can be as shown in the image:



ADD INTEGRATION

HTTP Integration (v2.6.0)
The Things Industries B.V.
Sends uplink data to an endpoint and receives downlink data over HTTP.
[documentation](#)

Process ID
The unique identifier of the new integration process
mycs1234

Access Key
The access key used for downlink
default key [default](#) [message](#)

URL
The URL of the endpoint
http://YOUR_CUSTOMER_SERVER_URL/api/parking/v2/services/ttn

Method
The HTTP method to use
POST

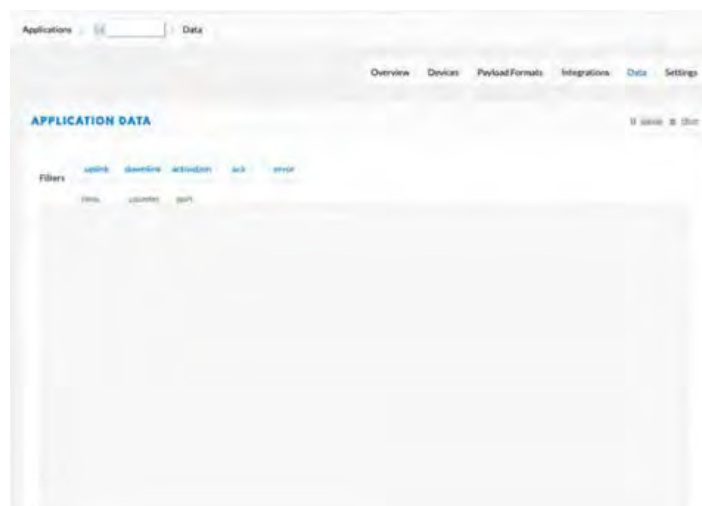
Figure : Configuration on an HTTP integration with the Customer Server on TTN

The rest of the integration fields **must be blank**.

Data visualization

This is one of the most important options on TTN. Here the user can see the data sent (both uplink and downlink). Also, the errors and successes on the communication process are shown.

The user must use this section to make sure that the uplink and downlink communications are correct:



Applications: Data

Overview Devices Payload Formats Integrations **Data** Settings

APPLICATION DATA

Filters: [uplink](#) [downlink](#) [acknowledgment](#) [ack](#) [error](#)

time counter port

Figure : Data screen on an integration on TTN

Application settings

This section is a quick summary of the application settings as Handler, EUIs and Access Keys, among others.

The user can change the parameters but it is possible to create here some misconfiguration on the application settings. Also, on the bottom there is a "Delete application APP_NAME" button that deletes the application completely.



Figure : Settings for an application on TTN

6.4. The Things Industries (TTI)

This section explains how to route information on TTI to the Customer Server or to the Smart Parking Cloud Service, using the HTTP protocol. TTI is a free and ready to use cloud for LoRaWAN communications. TTI gives the user a wide variety of integrations ready to use.

6.4.1. Log in

Open a new window on your web browser and type the login URL provided by [The Things Industries](#).

Request a quotation to get the login URL if you do not have it yet. Then, login with the URL and credentials supplied to you by TTI.

After a successful login, the main panel will be shown. From this screen the user can access different sections to manage her devices and view data:

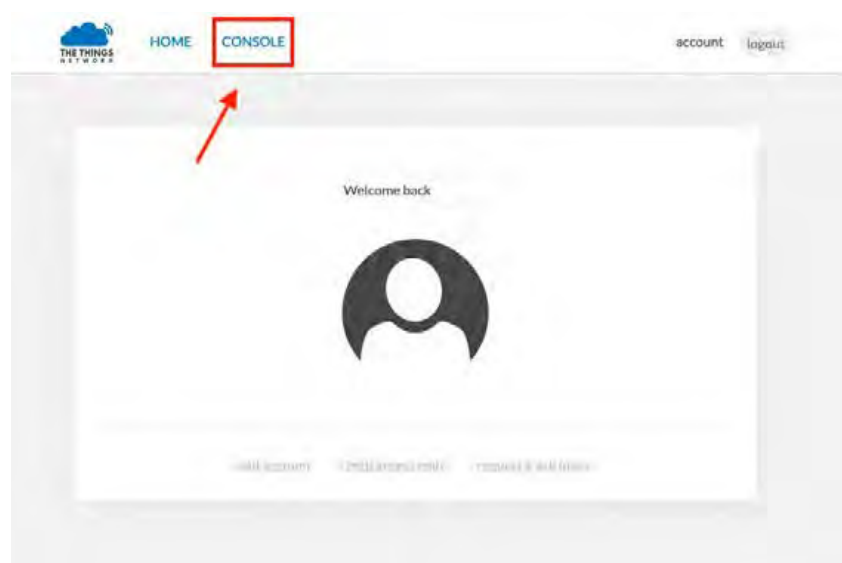


Figure : Main screen on TTI

Click on "Console" to open the 2 main sections on TTI: one for applications and one for gateways.

6.4.2. Manage gateways

Select "Gateways" to manage your devices. You can see a list of them (if you already created some gateways) or you can create a new gateway device:

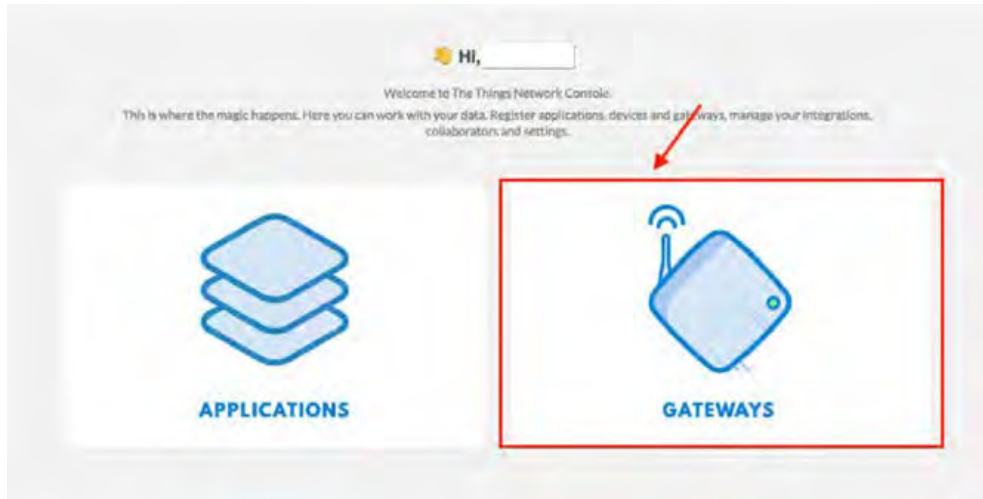


Figure : Main sections on TTI - Gateways

Register a new gateway

To register a new gateway, click on "Register gateway". A new form is displayed:

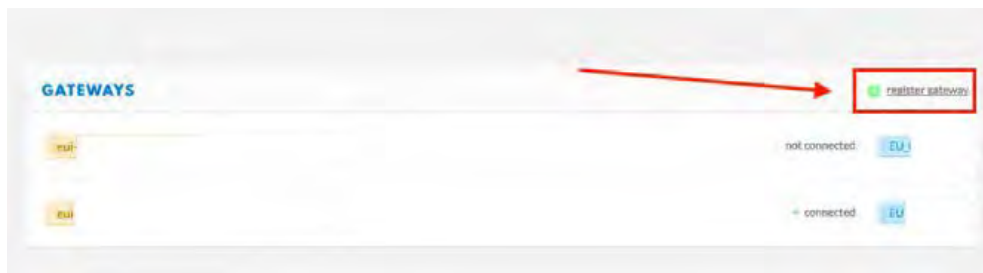


Figure : Create new gateway on TTI

On the gateway form, enter the following data to create a new one:

1. Gateway ID: A unique and human-readable identifier for the gateway.
2. Description: The gateway description.
3. Frequency Plan: This parameter belongs to each country regulation, for more information please visit [this link](#).
4. Router: Select the gateway to connect, choose the closest one to your location to get a better coverage.
5. Location: Set the location on the map.
6. Antenna Placement: Choose between indoor or outdoor.

Gateways **Register**

REGISTER GATEWAY

Gateway ID
A unique, human-readable identifier for your gateway. It can be anything so be creative!

☐ **I'm using the legacy packet forwarder**
Select this if you are using the legacy [Semtech packet forwarder](#).

Description
A human-readable description of the gateway

Frequency Plan
The frequency plan this gateway will use

no selection

Router
The router this gateway will connect to. To reduce latency, pick a router that is in a region which is close to the location of the gateway.

Figure : Create new gateway on TTI - Step 1

Location
The exact location of your gateway. This will be used if your gateway cannot determine its location by itself. Set a location by clicking on the map.

Antenna Placement
The placement of the gateway antenna

Indoor outdoor

Cancel Register Gateway

Figure : Create new gateway on TTI - Step 2

After filling all the fields, press "Register gateway" to confirm this new device.

Gateway settings

By clicking on the new created gateway a new screen summarizing the information will appear. The user can edit the gateway information, change the settings, delete the registered gateway and see the traffic on the gateway.

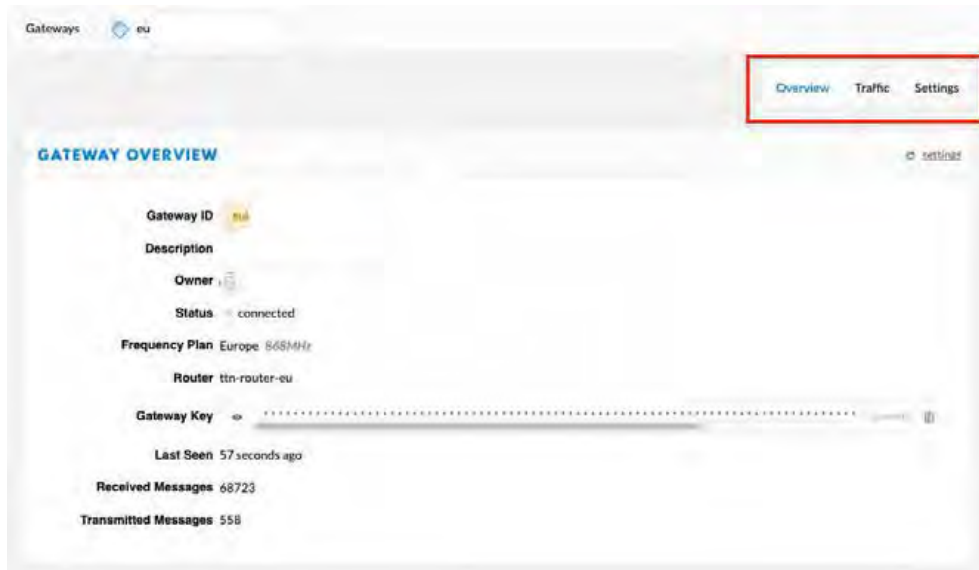


Figure : Summarized information and edit settings on TTI

An important option for the gateway is present on "Settings": at the bottom of the page there is a red button called "Delete gateway eui-XXX". This is used to perform a full deletion of the gateway. Do not click this option if you want to preserve your gateway as registered.

6.4.3. Manage applications

The "Applications" section permits to view, edit and create applications, as well as view data and integrate it with other clouds.

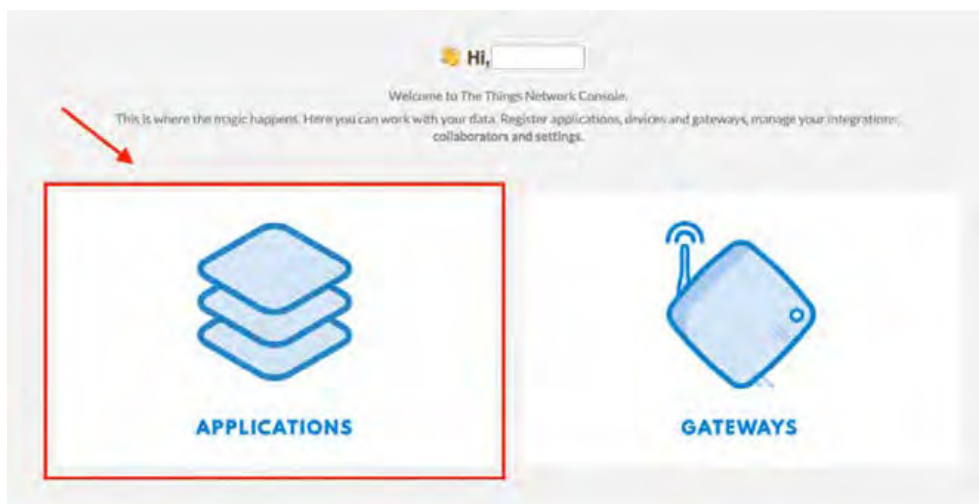


Figure : Main sections on TTI - Applications

After clicking on "Applications", a list of them will appear if the user has already created applications.

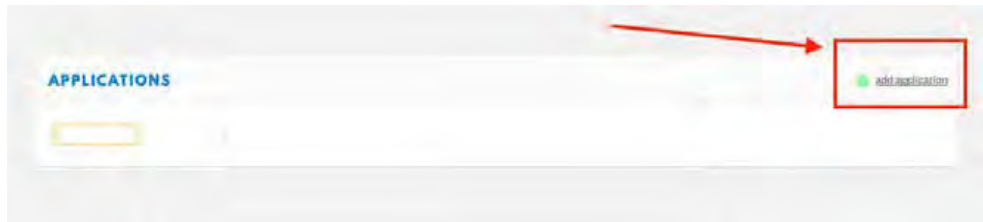


Figure : List of applications on TTI

On the top right corner there is an "Add application" button to register a new application, click on this option to create a new one. Fill all the information and press "Add application" to confirm the data:

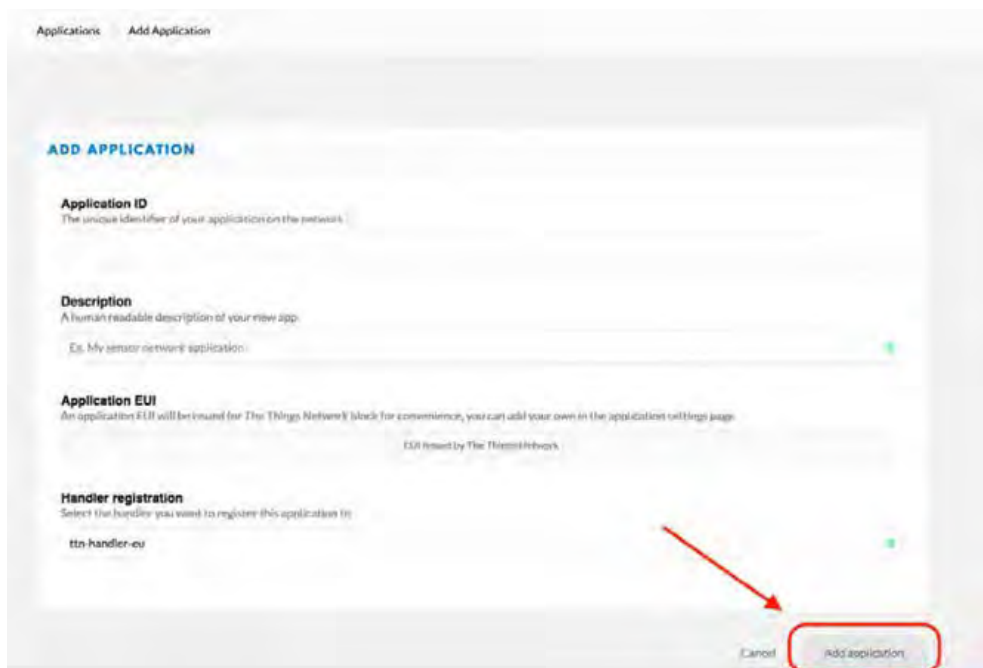


Figure : Add new application on TTI

Options and device registration overview

There are plenty of options to configure an application. This guide will guide you through the most important options to accomplish the integration with the Customer Server or with the Smart Parking Cloud Service.

The main screen shows a summary about the application, the registered devices and the access key (important for the Integrations section):

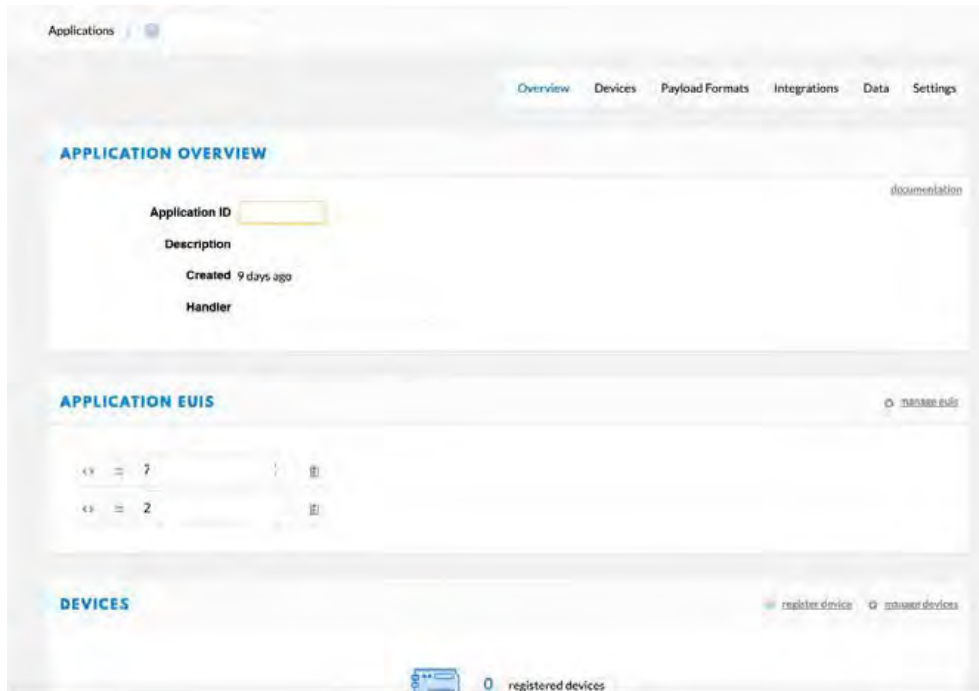


Figure : Application overview on TTI

On the top right area of the "Devices" section it is possible to register a new device for the application. Creating a new device is not required to perform the integration with the Customer Server or with the Smart Parking Cloud Service.

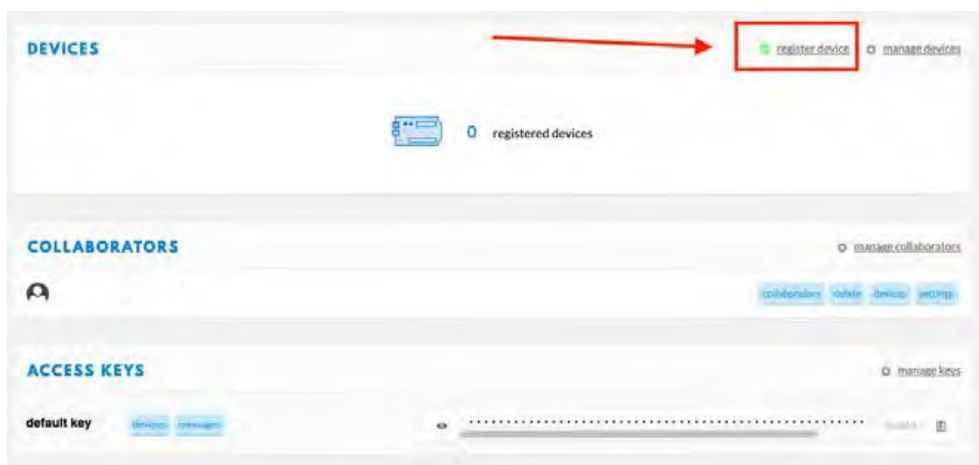


Figure : Registering a new device for an application on TTI

To create a new device, fill all the fields:

- Device ID: The unique identifier for the device in the application.
- Device EUI: The unique identifier for the device on the network.
- App Key: Used to create a secure communication between the device and the network.

Important:

The Device ID must be the same as LoRaWAN EUI in lowercase to match the communication with the Customer Server or with the Smart Parking Cloud Service.

After setting these fields, hit the "Register" button to finish the registration.

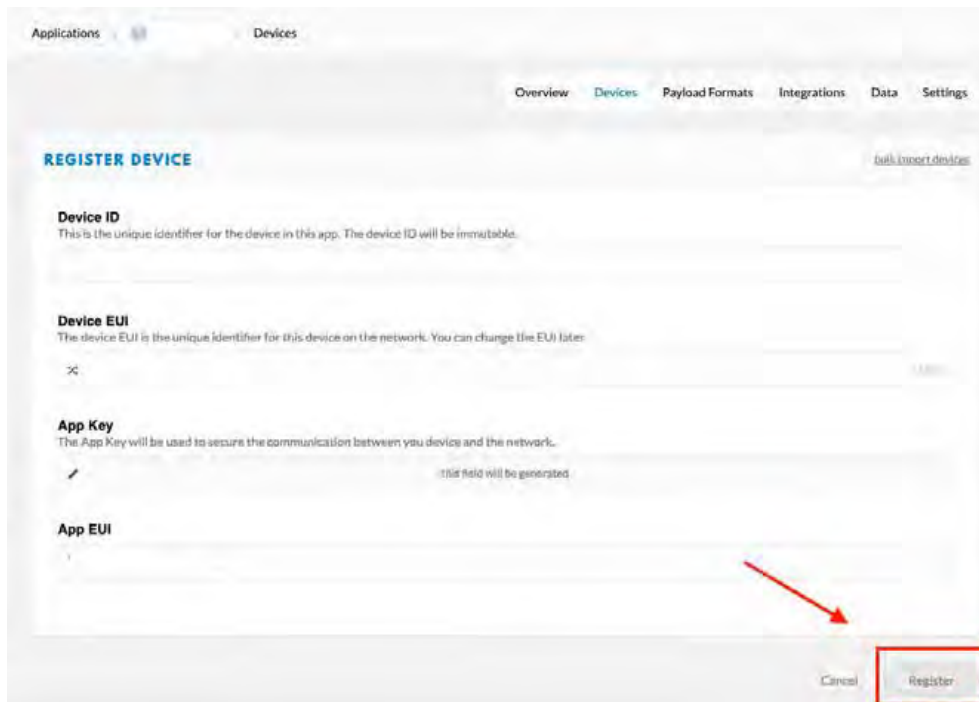


Figure : Form to create a new device on TTI

There is also a chance to register more that one device in bulk using the "Bulk import devices" button placed on the top right:

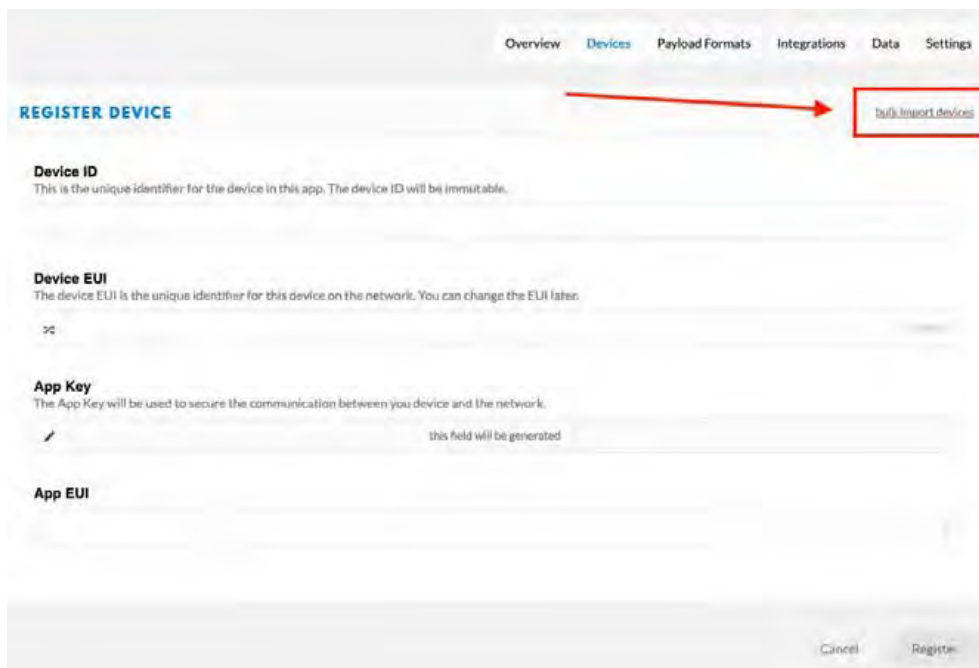
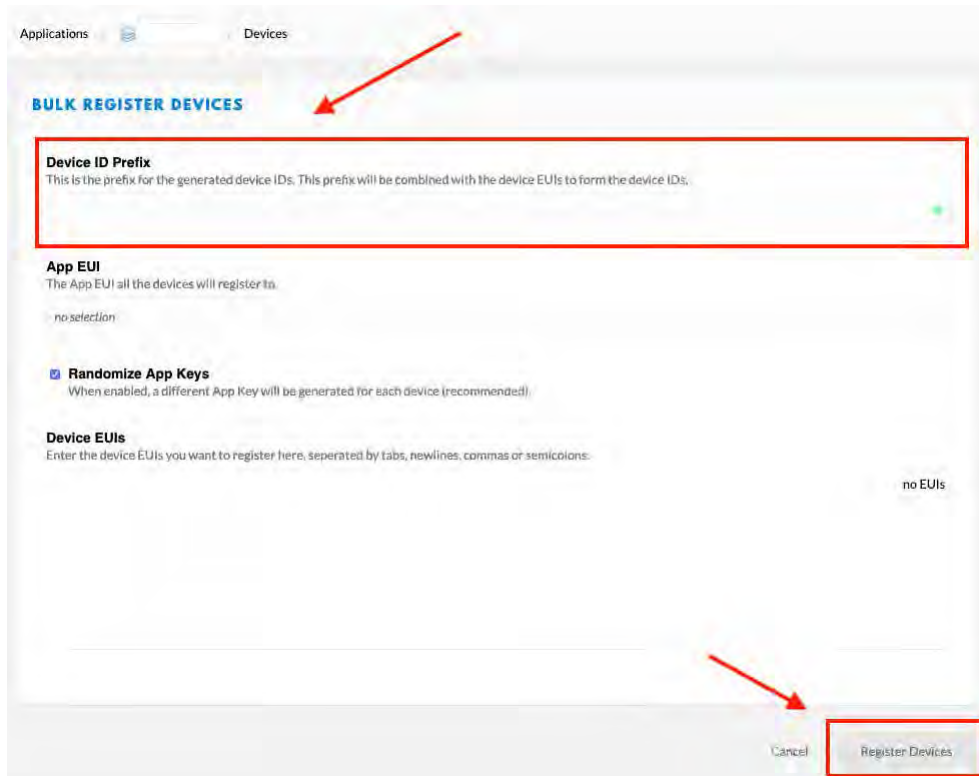


Figure : Bulk devices import on TTI

The screen for a bulk import is very simple:



BULK REGISTER DEVICES

Device ID Prefix
This is the prefix for the generated device IDs. This prefix will be combined with the device EUIs to form the device IDs.

App EUI
The App EUI all the devices will register to.
no selection

☒ **Randomize App Keys**
When enabled, a different App Key will be generated for each device (recommended).

Device EUIs
Enter the device EUIs you want to register here, separated by tabs, newlines, commas or semicolons.
no EUIs

Cancel Register Devices

Figure : Bulk devices import form on TTI

The parameters to fill are:

- Device ID Prefix: This is the prefix for the generated device IDs.
- App EUI: The App EUI all the devices will register to.
- Randomize Keys: If enabled, a different App Key will be generated for each device (recommended).
- Device EUIs: The device EUIs to register, separated by tabs, newlines, commas or semicolons.

Important:

The Device ID Prefix must be left in blank to match the communication with the Customer Server or with the Smart Parking Cloud Service.

After entering all the parameters, press "Register devices" to finish the bulk registration process.

Application integrations

Another important section for each application is "Integrations" section. There the user can send data to third-party clouds and also to the Customer Server or to the Smart Parking Cloud Service.

Click on "Add integration" to create a new mechanism to send data:

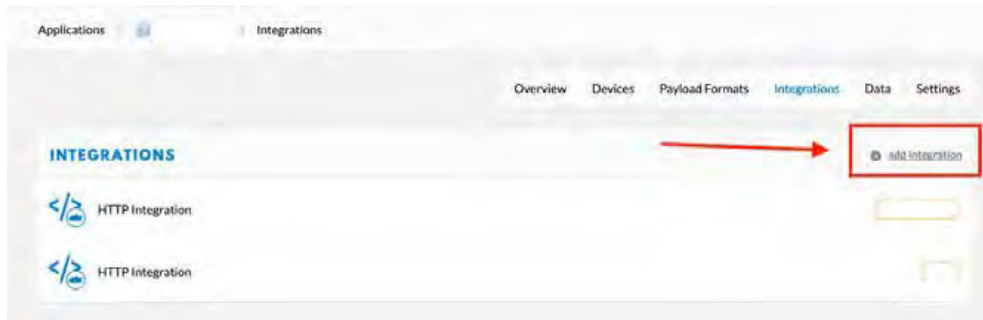


Figure : Integrations screen on TTI

After clicking "Add integration", a list of third-party clouds will be displayed, choose "HTTP integration" to configure TTI to send towards the Customer Server or the Smart Parking Cloud Service:

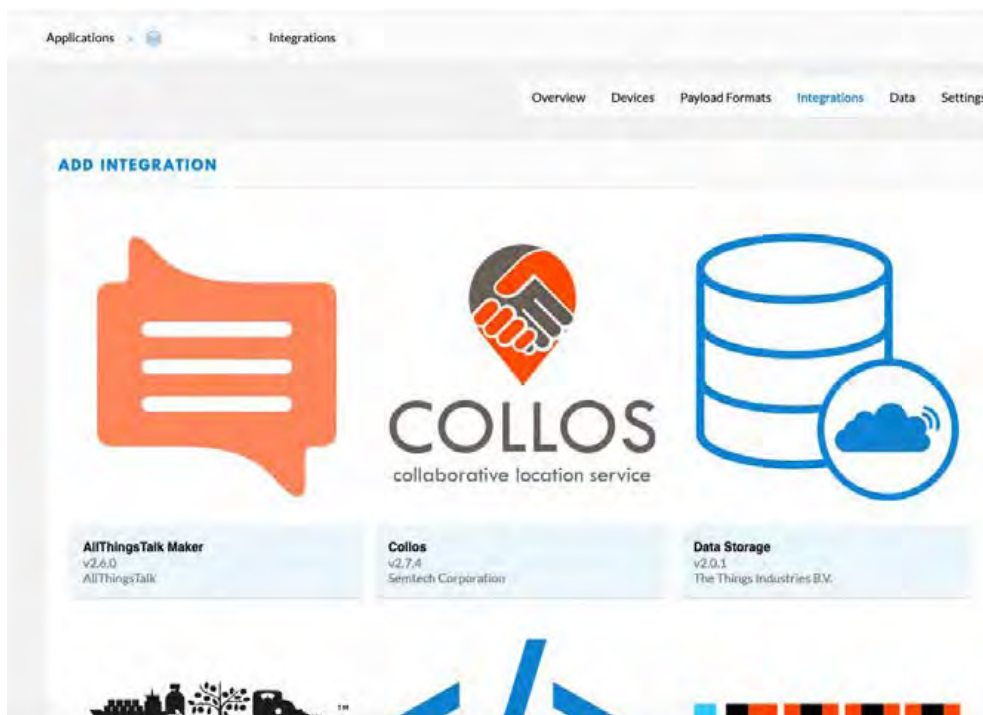


Figure : Integrations list on TTI

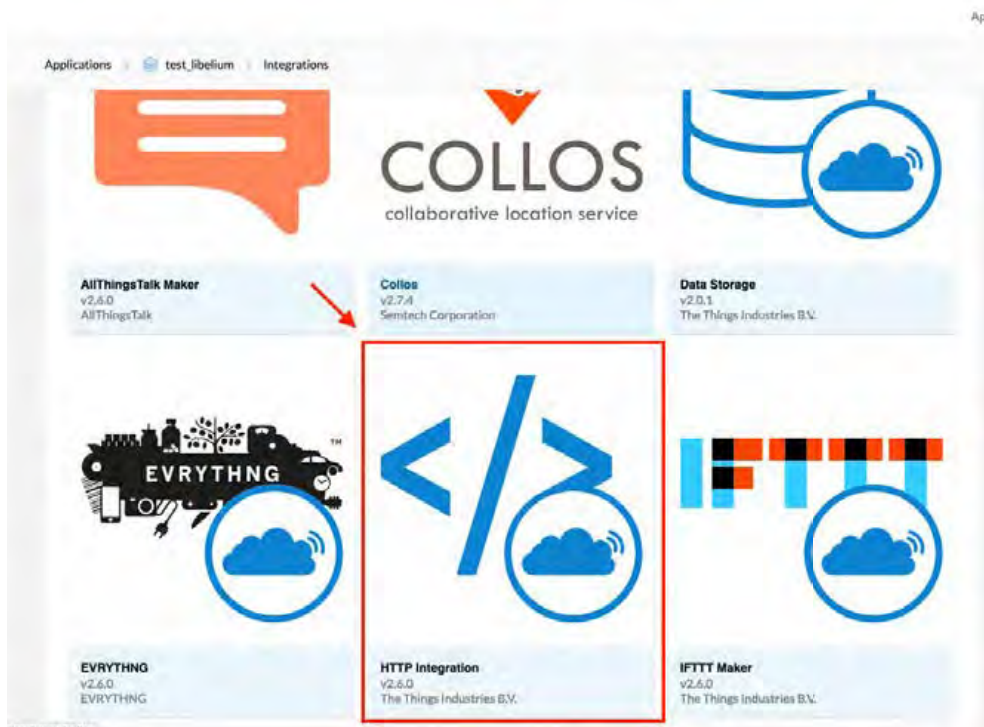
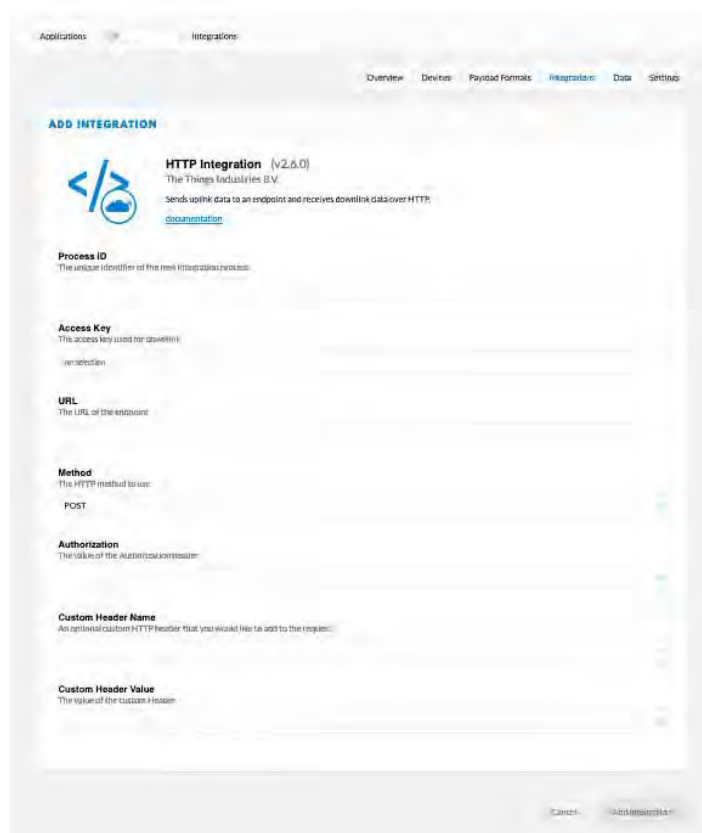


Figure : HTTP integration option on TTI

The form for HTTP connection is as follows:



ADD INTEGRATION

HTTP Integration (v2.6.0)
The Things Industries B.V.
Sends uplink data to an endpoint and receives downlink data over HTTP.
[documentation](#)

Process ID
The unique identifier of the new integration process.

Access Key
This access key is used for downlink.
[text input]

URL
The URL of the endpoint.
[text input]

Method
The HTTP method to use:
POST

Authorization
The value of the authorization header.
[text input]

Custom Header Name
An optional custom HTTP header that you would like to add to the request.
[text input]

Custom Header Value
The value of the custom header.
[text input]

[Cancel](#) [Save Integration](#)

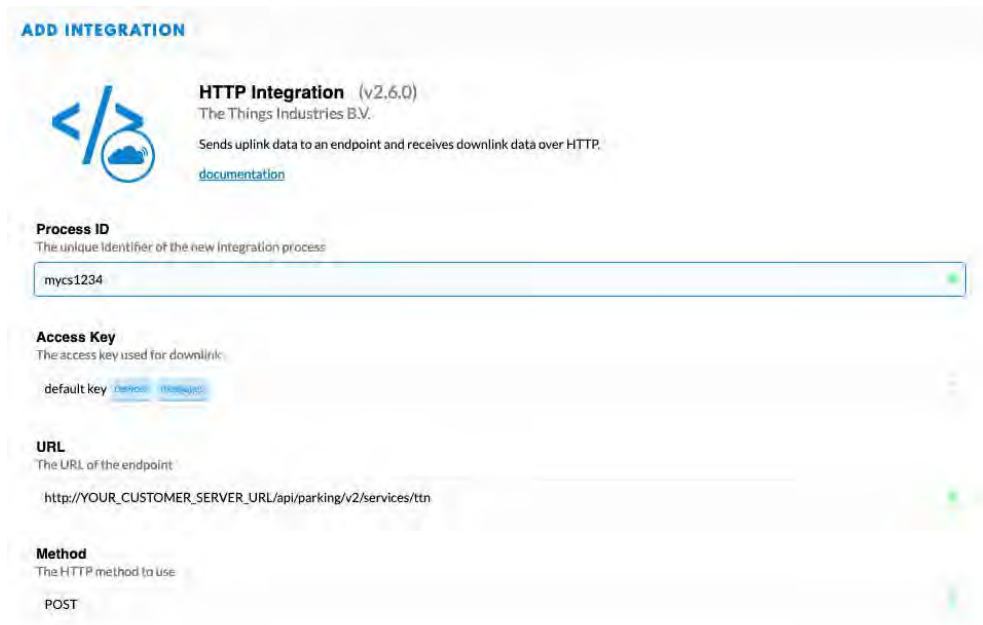
Figure : HTTP integration form on TTI

There are some fields to fill on the form:

- Process ID: The unique identifier of the new integration process. Free text.

- Access Key: The access key used for downlink. It is the default key in most cases.
- URL: The Customer Server URL: `http://YOUR_CUSTOMER_SERVER_URL/api/parking/v2/services/tti`.
- Method: The HTTP method to use. For Customer Server integration, it must be "POST".

An example of configuration integration for Customer Server can be as shown in the image:



ADD INTEGRATION

HTTP Integration (v2.6.0)
The Things Industries B.V.
Sends uplink data to an endpoint and receives downlink data over HTTP.
[documentation](#)

Process ID
The unique identifier of the new integration process
mycs1234

Access Key
The access key used for downlink
default key [default](#) [message](#)

URL
The URL of the endpoint
http://YOUR_CUSTOMER_SERVER_URL/api/parking/v2/services/tti

Method
The HTTP method to use
POST

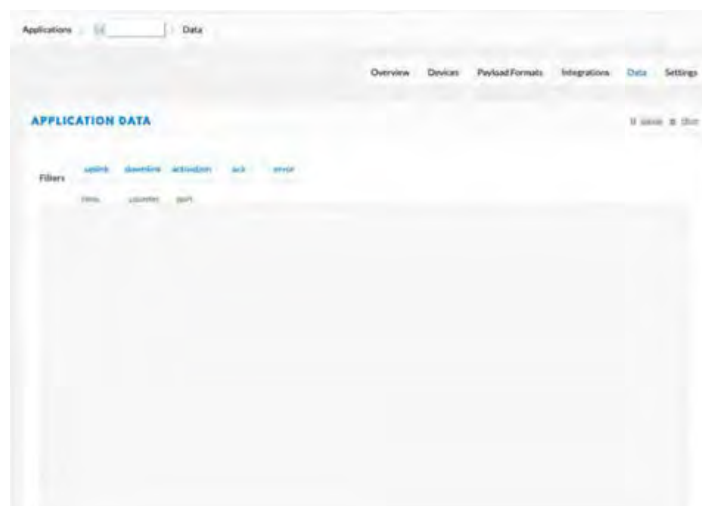
Figure : Configuration on an HTTP integration with the Customer Server on TTI

The rest of the integration fields **must be blank**.

Data visualization

This is one of the most important options on TTN. Here the user can see the data sent (both uplink and downlink). Also, the errors and successes on the communication process are shown.

The user must use this section to make sure that the uplink and downlink communications are correct:



Applications: Data

Overview Devices Payload Formats Integrations **Data** Settings

APPLICATION DATA

Filters: [uplink](#) [downlink](#) [acknowledgment](#) [ack](#) [error](#)

time counter port

Figure : Data screen on an integration on TTI

Application settings

This section is a quick summary of the application settings as Handler, EUIs and Access Keys, among others.

The user can change the parameters but it is possible to create here some misconfiguration on the application settings. Also, on the bottom there is a "Delete application APP_NAME" button that deletes the application completely.



Figure : Settings for an application on TTl

6.5. MultiTech basestation

This section explains how to route information on a MultiTech basestation to the Customer Server or to the Smart Parking Cloud Service, using the MQTT protocol.

MultiTech basestations come with an Embedded Network Server for LoRaWAN, free of cost or annual fees. Besides, Libelium customers can purchase special models of MultiTech basestations which are ready to use, since they have our "Custom Application" already installed. This Custom App enables automatic communication between Smart Parking nodes and our Smart Parking Cloud Service. These special basestation models are called "Smart Parking configured".

6.5.1. Libelium's Custom App

Some MultiTech basestations come with the Libelium's Custom App already installed on our facilities. Please go to the section "Installing/upgrading Libelium Custom App" if your basestation does not have it, or if you want to upgrade the version of the Custom App inside your basestation.

Important:

Our Custom App was developed for MultiTech's firmware 1.7.4 version. At the moment, the Custom App is not supported on firmware 5.0.0: this 5.0.0 version contains some known bug issues so it is not currently supported. More information on the "Compatible firmware versions" section.

Log in

To start the application, first go to the address where you installed your MultiTech basestation. By default, the configured address is <https://192.168.2.1>. Enter your credentials and press "Login".



Figure : MultiTech login panel

Starting the Custom App

Before accessing the application, it is recommended to check its status. Go to "Apps" in the menu.

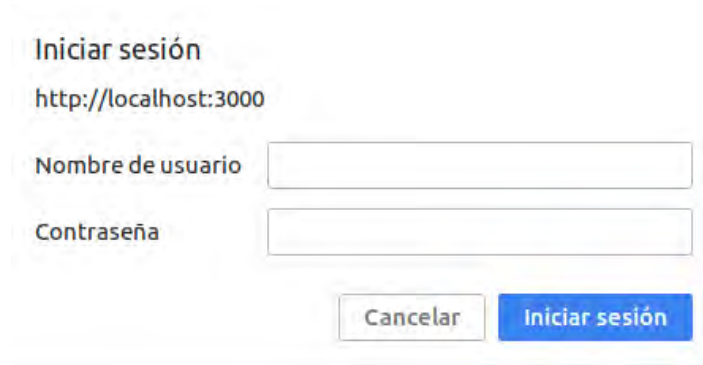
The application has 4 status:

1. **Stopped:** The application is stopped and cannot be accessed.
2. **Started:** The application is started and it will take a few minutes to be able to access the application, after pressing the "Play" button.
3. **Running:** The application is running. It is possible to access it through the address where it is installed, by adding port 3000.
4. **Failed:** The application has failed and it is necessary to restart it. An explanation about this status is in the "Info" field.

Accessing the Custom App

Open a new tab on your web browser and enter the credentials to access the application. By default, the credentials are:

1. **Username:** admin
2. **Password:** admin



The login form is titled "Iniciar sesión" and shows the URL "http://localhost:3000". It contains two input fields: "Nombre de usuario" and "Contraseña". Below the fields are two buttons: "Cancelar" and "Iniciar sesión".

Figure : Custom App login

If you want to change the default credentials, please read the "Change default access credentials" section.

Configs tab

If you select the "Libelium Smart Parking Cloud Service" option, you must fill the "Token" field to send the node's frames to our Smart Parking Cloud Service. Please refer to "[Tools](#)" section for further information about to how to create a token. Once you have created the token, paste in the field.



The configuration form for the "Smart Parking Cloud Service" option shows the "Select Configuration" dropdown set to "Libelium Cloud". The "TOKEN" field is empty. A "Save Configs" button is at the bottom.

Figure : MultiTech configuration - Smart Parking Cloud Service option

If you select the "Customer Server" option, you must fill the "URL" field to send the node's frames to your Customer Server.



The configuration form for the "Customer Server" option shows the "Select Configuration" dropdown set to "Customer Server". The "URL" field contains the value "/api/parking/v2/services/multitech". A "Save Configs" button is at the bottom.

Figure : MultiTech configuration - Customer Server option

Regardless of the method you have used, save the configs clicking the "Save configs" button. If the introduced value is valid, a pop-up window will appear confirming that the configuration has been saved:

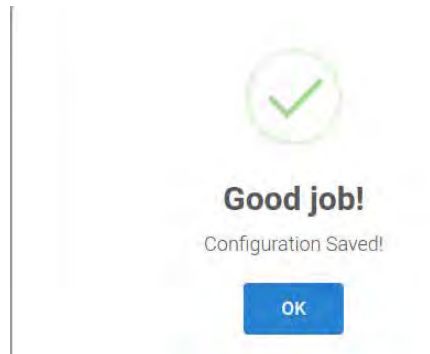


Figure : MultiTech configuration saved

If the field does not have a valid configuration, a window will tell you need to review the configuration before saving:

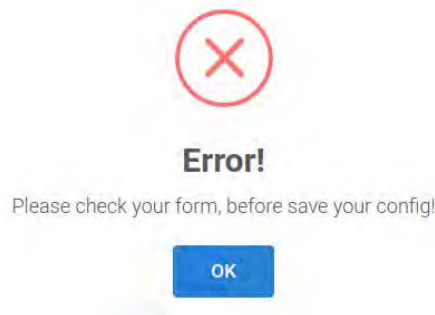


Figure : MultiTech configuration error

Devices Provisioning tab

Thanks to this feature you can register all the devices at once. Just enter all your devices the text box "Import your Devices", in comma-separated format (one device per line).

The format to use is:

```
<DevEUI_1>,<Serial>,<AppEUI_1>,<AppKey_1>
<DevEUI_2>,<Serial>,<AppEUI_2>,<AppKey_2>
<DevEUI_3>,<Serial>,<AppEUI_3>,<AppKey_3>
...
<DevEUI_N>,<Serial>,<AppEUI_N>,<AppKey_N>
```

On the Services Cloud Manager (SCM) you can download a CSV file with all your devices (all the devices associated with on your SCM account). To download the file, 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.

Logs tab

The "Logs" tab shows the information and error messages of the communication requests of the LoRaWAN services. All messages related to the transport layer of the service are identified as INFO or ERROR. User intervention may

be required to analyse the meaning of the messages generated in the application layer and decide if some actions are needed.

```

[1 info] 2019-08-07T08:48:52.683Z - topic: lora/00-04-a3-00-00-20-fa-49/up
[1 info] 2019-08-07T08:48:59.362Z - Smart Parking server response code: 200
[1 info] 2019-08-07T08:48:59.811Z - message: {"task":3514651548,"chan":7,"rfch":1,"freq":367.9,"stat":1,"modu":"LORA","dat":{"SF12M125","codr":4/3,"lsnr":3.8,"rssi":-107,"opts":"","size":1
[1 info] 2019-08-07T08:48:59.799Z - topic: lora/00-04-a3-00-00-20-fa-49/up
[1 info] 2019-08-07T08:47:43.529Z - subscribed!
[1 info] 2019-08-07T08:47:43.463Z - MQTT connected, subscribing...
[1 info] 2019-08-07T08:47:43.679Z - Updating status file with pid [19225] and message {listening on port 3000 as of Wed Aug 07 2019 08:47:43 GMT+0000 (UTC)}
[1 info] 2019-08-07T08:47:43.652Z - Launch APP
[1 info] 2019-08-07T08:47:43.639Z - App listening on port 3000
[1 info] 2019-08-07T08:47:31.722Z - ----- STARTING APP -----
[1 info] 2019-08-07T08:39:11.997Z - subscribed!
[1 info] 2019-08-07T08:39:11.932Z - MQTT connected, subscribing...
[1 info] 2019-08-07T08:39:11.530Z - Updating status file with pid [16411] and message {listening on port 3000 as of Wed Aug 07 2019 08:39:11 GMT+0000 (UTC)}
[1 info] 2019-08-07T08:39:11.534Z - Launch APP
[1 info] 2019-08-07T08:39:11.529Z - App listening on port 3000
[1 info] 2019-08-07T08:39:06.318Z - ----- STARTING APP -----

```

Figure : Logs section

The messages will appear in ascending order, showing the newest messages at the top. You can change the order by clicking the "Ascending" or "Descending" button.



Figure : Ascending button

Click the "Refresh" button to update the log view and load new messages. The latest messages appear at the top.

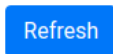


Figure : Refresh button

Change default access credentials

In order to change the password or user that the application brings by default, you have to connect through SSH to the MultiTech basestation. Once connected, navigate to where the configuration file is located at (var/config/app/libelium-multitech-app) and edit the ".env" file:

```
# If you want to change the username and password to access de application:
```

```
APP_USERNAME= 'admin'
```

```
APP_PASSWORD= 'admin'
```

Once you have changed the default username or password and saved the file, you need to stop the application and restart it for the changes to take effect.

Change the default listening port

In order to change the port where the application listens by default, you have to connect through SSH to the MultiTech basestation. Once connected, you have to navigate to where the configuration file is located at: "var/config/app/libelium-multitech-app" and edit the ".env" file:

If you want to use another port you must to change the APP_PORT field:

APP_PORT= '3001'

Once you have changed the default port and saved the file, you need to stop the application and restart it for the changes to take effect.

How to create a single device manually

To register the devices you have to go to "LoraWANTM" > "Key Management > "Add Device".

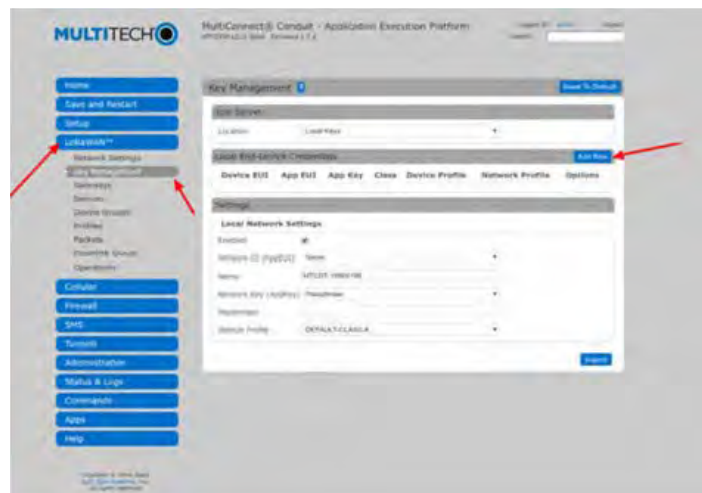


Figure : Registering a device manually - 1

Then click on "Add new". A new pop-up window will open with a form so you can fill the parameters of the nodes. The fields "Dev EUI", "App EUI" and "App Key" are mandatory to properly register the device.

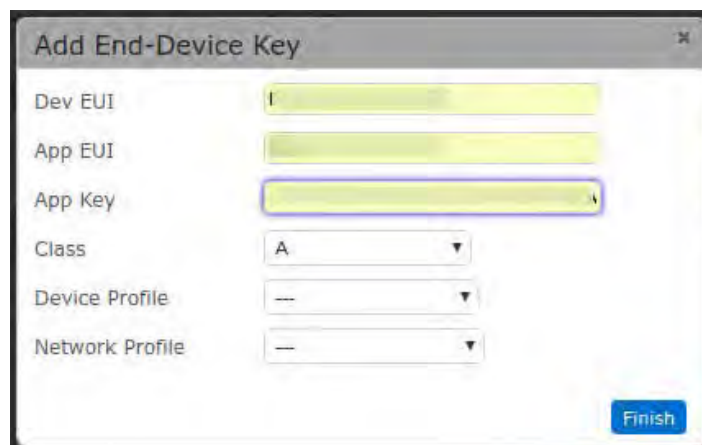


Figure : Registering a device manually - 2

Once the form is completed, the list of devices will be updated automatically with the device you just registered.


Local End-Device Credentials							Add New
Device EUI	App EUI	App Key	Class	Device Profile	Network Profile	Options	
00-0C	2 00-0C	****	A	null	null		 

Figure : Registering a device manually - 3

Restart the MultiTech basestation

When you have finished the provisioning of your devices, regardless of the method you have used, you need to restart the MultiTech, so that changes take effect.

We return to access the URL where we have the application installed; if the "Save & Restart" button is red, it indicates that there are pending changes to be saved and that it is necessary to perform a restart of the MultiTech basestation. To do so, go to the menu on the left, and press the "Save & Restart" button.



Figure : Restart button - MultiTech basestation

6.5.2. Compatible firmware versions

Below we show a list of the compatibility of the Custom App with versions of MultiTech basestations firmware:

- **5.0.0:** It contains some known bug issues so it is not currently supported.
- **1.7.x:** Totally compatible

6.5.3. Installing/upgrading Custom App

Log in DeviceHQ

Open a new window on your web browser and type <https://www.devicehq.com/>. It is a repository where MultiTech offers different apps and software.

Create a new user account if you do not have one yet. If you have an account, enter your credentials to perform the next steps.



Figure : Create account or login on DeviceHQ

DeviceHQ panel

After a successful login, the main panel appears. The user can see many options to manage devices, install applications, upgrade the firmware, see logs, etc:

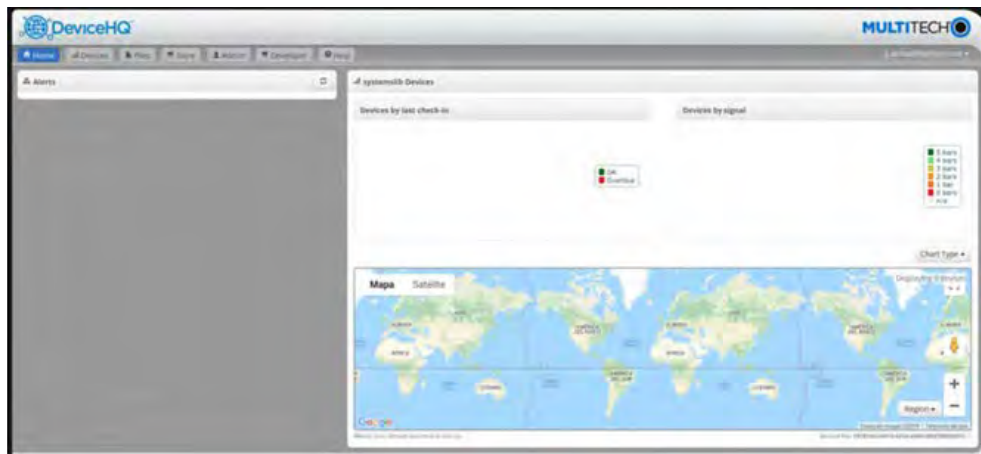


Figure : DeviceHQ main panel

Registering a MultiTech device on DeviceHQ

Once inside the DeviceHQ panel, go to "Devices" > "Tasks" > "Register devices".



Figure : Registering a MultiTech device on DeviceHQ panel

A new pop-up window appears. In the "Serial" field you must type the MultiTech serial and on the "UUID" field you must type the MultiTech UUID. Then click on the "Register device" button.

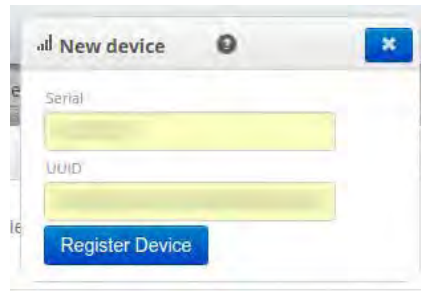


Figure : Registering a MultiTech device on DeviceHQ Panel

Important:

You can find all this information on the right side or on the back of your device.

Add Libelium Custom App to your store

To add the Custom App, go to "Store" on the top menu of the DeviceHQ panel and check the "Public apps" option to see all the public apps. Then search the "libelium-multitech-app". Once you have found it, click on Add to My Apps and again on the "Add to my apps" button.

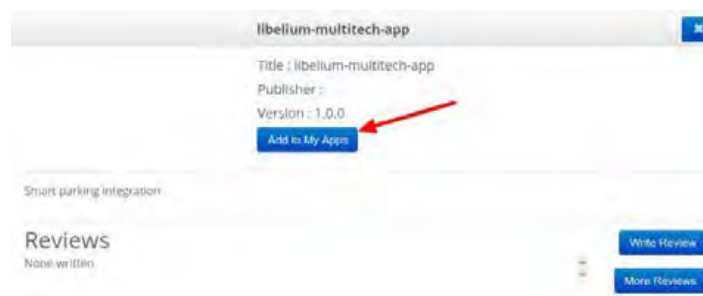


Figure : Add Libelium MultiTech application (our Custom App)

Please accept the licensing agreement and click on "Accept".



Figure : Accepting the licensing agreement

Enable Remote Management

Once inside the MultiTech basestation panel, go to "Administration" > "Remote Management". Then type your Account Key in the dedicated field.



Figure : Enable remote management

Click on the "Submit" button. Once changes have been saved, the Multitech must be restarted for the changes to take effect, so press the "Save & Restart" button.

Schedule install or upgrade the Custom App

In the DeviceHQ panel, "Devices" section, click on the selected device > "Schedule" > "Install app" and select the version that you want to install or upgrade.

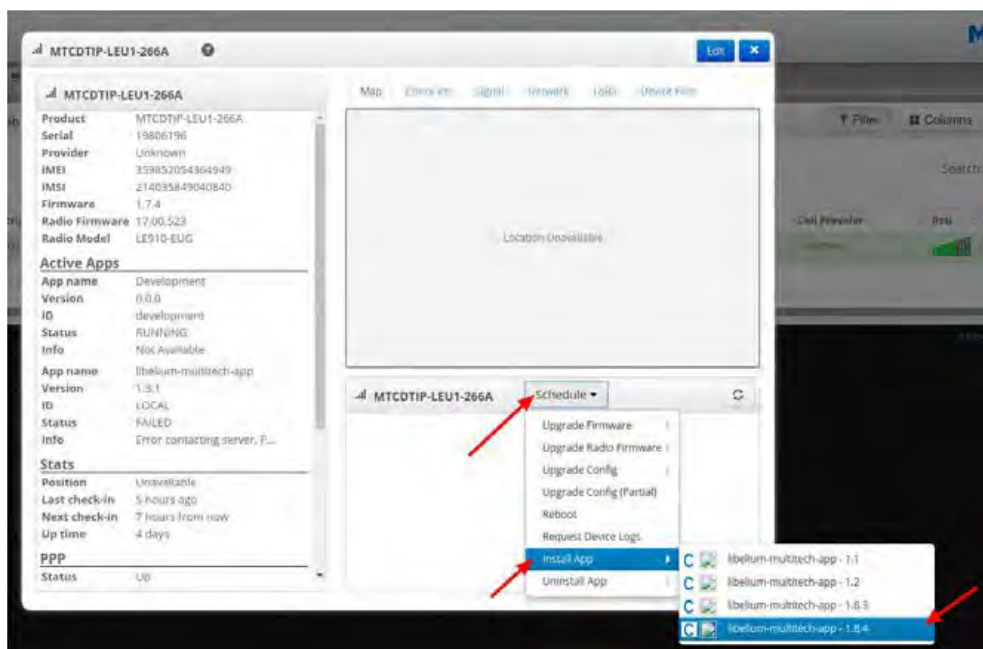


Figure : Install/upgrade the Custom App

Once you have scheduled an action, you must check the DeviceHQ server and poll the next actions. Read next section for more info.

Checking DeviceHQ from MultiTech

The MultiTech basestation will check the DeviceHQ server and poll it for commands such as configuration update, install and uninstall apps and other actions. For this action you must go on "Administration" > "Remote Management" > "Current Status" and press the "Check-in to DeviceHQ" button.

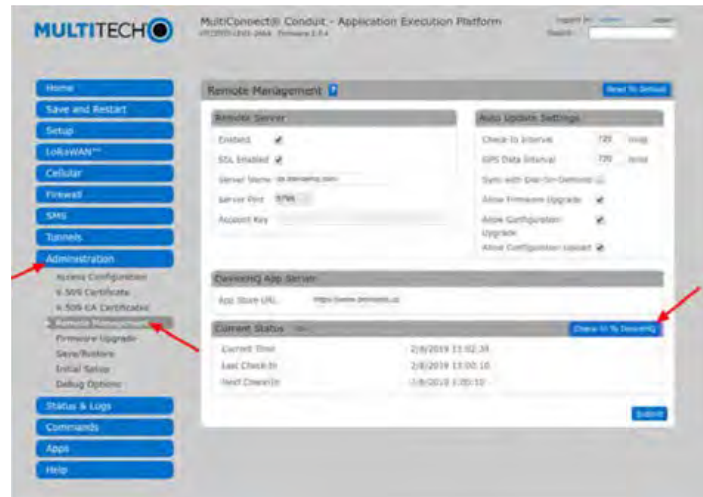


Figure : Check-In to DeviceHQ

7. Customer Server

In order to communicate with any LoRaWAN Network Server you need a web application up and running. The web application will receive LoRaWAN requests via POST/GET requests depending on the server. Libelium provides the source files of a simple web application called Customer Server, created to be deployed on your server.

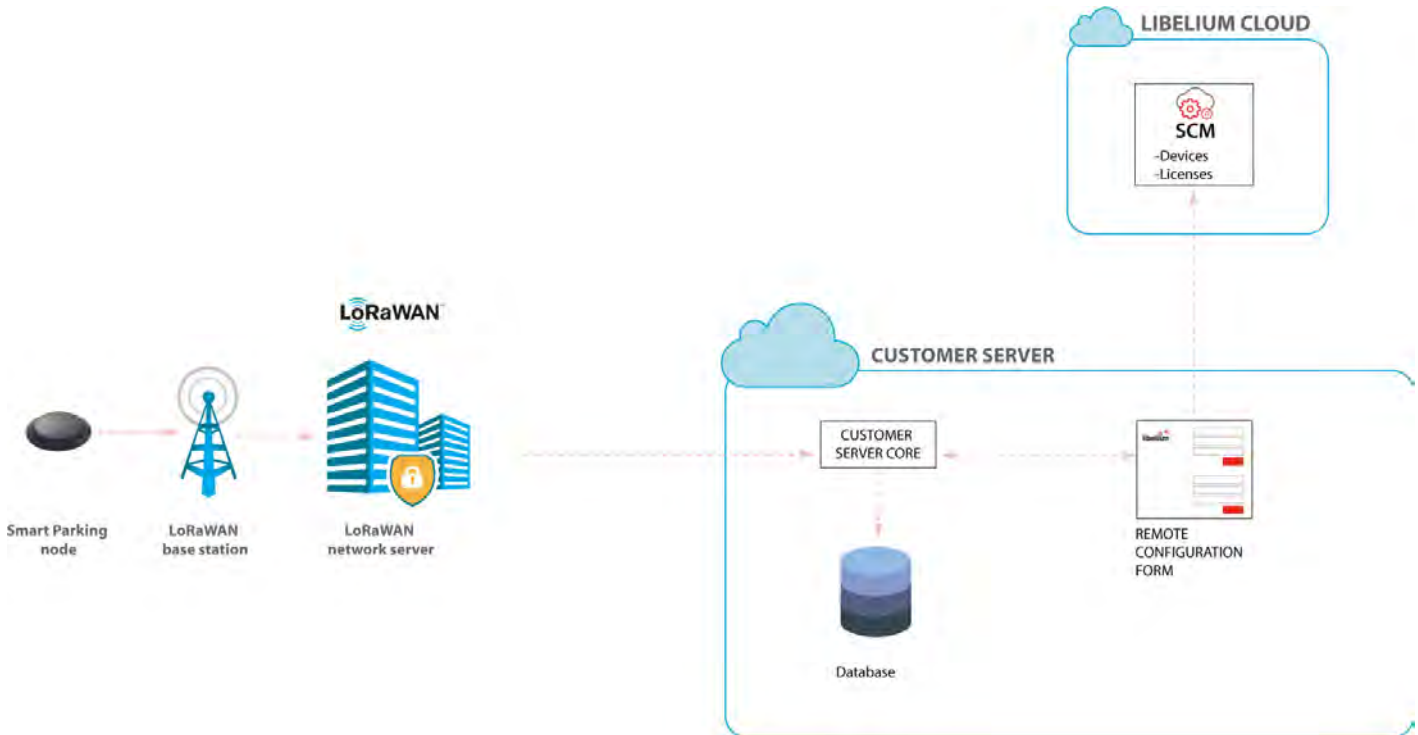


Figure : Customer Server

The Customer Server is composed of 2 parts:

- the Remote Configuration Form: it manages the configuration values of the Smart Parking nodes
- the Customer Server Core: it deals with the LoRaWAN Network Server requests, sending back a response when needed.

If the user wants to use the Remote Configuration Form, all Smart Parking nodes must be registered on the SCM. There is no need of additional licenses.

The Customer Server must be deployed on your own server. Besides, the LoRaWAN Network Server must be configured with the complete URL containing your server domain name or IP. The context should point to the web application deployment path.

Note: Customers can ask for this source code to our Sales Team (sales@libelium.com) after buying the nodes.

7.1. Installation

There are 2 ways to install the Customer Server: installing it on your own server with Docker or installing it manually on your own server.

Assigning a public IP and a registered domain name to the server is recommended to ease the task of configuring LoRaWAN Network Server to send HTTP/HTTPS requests to this server. It is also a good practice to implement existing security policies (user credentials, SSL, firewall, and tools to avoid DoS attacks) for servers with open ports to Internet.

7.1.1. Docker

If you want to use Docker, you must install Docker and Docker Compose on your server. In order to install these tools, you should follow the instructions from the official documentation by Docker:

- Docker installation instructions: <https://docs.docker.com/install/>
- Docker Compose installation instructions: <https://docs.docker.com/compose/install/>

You can also hire online services which offer a virtual server with Docker already installed on it.

7.1.2. Server

The minimum requirements for the server are:

- Apache web server ≥ 2.4
- PHP $\geq 7.1.3$
- Database: MySQL or PostgreSQL
- ionCube Loader

An Apache webserver with PHP support and a database must be configured on your server. Those are the minimum requirements to deploy the Customer Server web application.

Even if you are not using Docker, you can use 2 files as a reference to install all the dependencies of the project. These files are Dockerfile and docker-compose.yml, and can be found on the source code that the Sales Team provides (bin/ci/smart_parking).

Info and tutorials about installation of minimum requirements of your server:

- Ubuntu: <https://help.ubuntu.com/community/ApacheMySQLPHP>
- Windows: <http://www.ampsoft.net/webdesign-l/how-to-install-apache-php-mysql.html>
- Mac: <http://jason.pureconcepts.net/2012/10/install-apache-php-mysql-mac-os-x/>
- ionCube Loader: <http://www.ioncube.com/loaders.php>

Important:

In order to install the Customer Server using the server option, you will need access to your server to install all the dependencies and to configure the Apache server.

7.2. Deploying

7.2.1. Docker

- Step 1: Extract on your server the zip file provided by Libelium containing the Customer Server application source files.

- Step 2: Go to the folder `bin/ci/smart_parking`.
- Step 3: You should modify the files `Dockerfile` and `docker-compose.yml` that we provide in order to make sure that the security required for your project is matched.
- **Database:** We provide a file with the structure for the database, you can change the name of the main table and also use it to add any additional tables you may need, the file is located on:

```
bin/ci/smart_parking/docker-entrypoint-initdb.d/init.sql
```

This file will be executed one time when the database container is created and it should be added to the docker group.

- File structure: The application files should be placed in the “www-data” group from the web container. You can map a host user to www-data by UID as it is commented on the `Dockerfile` or you can assign the files to the correct UID (33 by default).
- Step 4: Execute “`docker-compose up`” to launch the project (the 1st time, it may take some time to execute).
- Step 5: You can check if the installation is completed navigating to “`http://MACHINE_IP:7000`”: you should see the Remote Configuration Form login screen.

Multiples instances

If you want to use the Customer Server with more than one application, you need to deploy one instance of the container for each application. You must follow the same steps explained above, but if the new installation is on the same machine you will have to change the application ports to avoid conflicts between the applications: modify the **docker-compose.yml** file of the new application and change the default ports (7000 for the web app and 7001 for the database).

Old file:

```
ports:
  - "7000:80"
ports:
  - "7001:3306"
```

New file:

```
ports:
  - "8000:80"
ports:
  - "8001:3306"
```

Note: The port can be any open port on your server.

7.2.2. Server

- Step 1: Extract on your server the zip file provided by Libelium containing the Customer Server application source files.
- Step 2: Check the right owner/group and permissions of all the files extracted, usually using www-data group is default in Ubuntu environment.
- Step 3: Check the permissions of all folders and files, usually using 0770 for directories and 0660 for files is default in Ubuntu environment.

- Step 4: Configure in your server the context of the callback server application with the path where the source files were extracted.

Copy and paste the following text as content of the file "my_server.conf" file located on "/etc/apache2/sites-available" (replace paths to match your server deployment locations):

```
<VirtualHost *:80>
    ServerAdmin webmaster@localhost
    ServerName my_server.com
    ServerAlias my_server.com

    DirectoryIndex index.html index.php
    DocumentRoot /path/zip/extracted

    ErrorLog ${APACHE_LOG_DIR}/error.log
    CustomLog ${APACHE_LOG_DIR}/access.log combined

    <Directory /path/zip/extracted>
        Options Indexes FollowSymLinks
        AllowOverride All
        Require all granted
    </Directory>
</VirtualHost>
```

Multiples instances

If you want to use the Customer Server with more than one application you will have to deploy one **VirtualHost** for each application, you will have to follow the same steps from above but you will have also to create another database and change the configuration on the **.env** file of your new VirtualHost to match your new name.

7.3. Configuring the application

Initialize the nodes storage:

```
cd src/storage/app/parking
cp nodes.example.json nodes.json
```

Copy "src/.env.example" to "src/.env" and edit the file:

```
APP_NAME='Smart Parking v2 - Customer Server'
APP_ENV=local
APP_DEBUG=false
APP_URL=http://localhost
APP_TIMEZONE=UTC

# Set to true to use the database:
USE_DB=false

# This data should match the data on the file docker-compose.yml:
DB_CONNECTION=mysql
DB_HOST=db
DB_PORT=7001
DB_DATABASE=LoriotDB
DB_USERNAME=user
DB_PASSWORD=password

CACHE_DRIVER=file
```

```
# It is mandatory to set a service (Loriot|Actility|LwTTN|LwTTI|Multitech):
SERVICE=''

# If you want to use Loriot you must fill these fields:
LORIOT_URI=''
LORIOT_APP_ID=''
LORIOT_TOKEN=''

LORIOT_API_KEY=''

# If you want to use Actility you must fill these fields:
ACTILITY_URI=''
ACTILITY_TOKEN=''
```

```
# If you want to use TTN you must fill these fields:
TTN_URI=''
TTN_REGION=''
TTN_APP_ID=''
TTN_PROCESS_ID=''
TTN_PORT=1
TTN_KEY=''

# If you want to use TTI you must fill these fields:
TTI_URI=''
TTI_APP_ID=''
TTI_PROCESS_ID=''
TTI_PORT=1
TTI_KEY=''
```

```
# If you want to use MultiTech you must fill these fields:
MTT_USERNAME= ''
MTT_PASSWORD= ''
MTT_URI= ''
```

You must specify which service you want to use; you must fill all the configuration fields for the selected one.

7.3.1. How to configure Lorient

Write "Lorient" in the "SERVICE" field:

```
SERVICE='Lorient'
```

For the remaining fields:

```
LORIENT_URI='https://serverID.lorient.io/1/'
```

"serverId" is the Lorient server from which your Lorient application is served, you can find it on the URL of your Lorient account.

```
LORIENT_APP_ID='appId'
```

"appId" is the ID of your Lorient application. You can find it on the "Network application" section of your Lorient account:

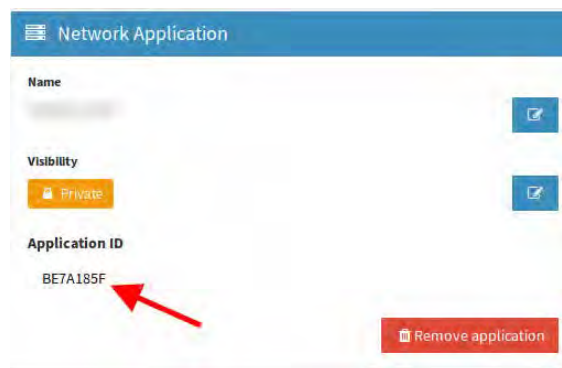


Figure : Lorient application ID

```
LORIENT_TOKEN='lorientToken'
```

"lorientToken" is the ID of your Lorient application. You can find it on the "Application tokens" section of your Lorient account:

```
LORIENT_API_KEY='lorientApiKey'
```

"lorientApiKey" is a key you can obtain on the "Account" section of the Lorient panel:



Figure : Lorient token

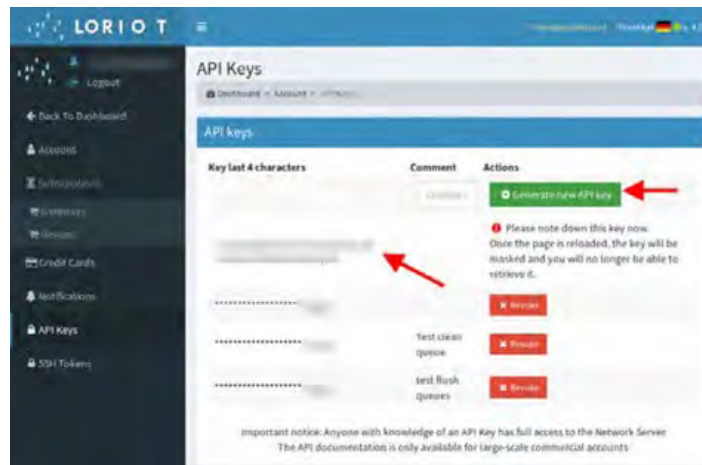


Figure : Lorient API key

7.3.2. How to configure Actility

Write "Actility" in the "SERVICE" field:

```
SERVICE='Actility'
```

And the remaining field:

```
ACTIVITY_URI='actilityURI'
```

"actilityURI" is the downlink URL that Actility provides to send information from the server to the node. This URL is the address of the primary Actility LRC cluster.

7.3.3. How to configure The Things Network (TTN)

Write 'LwTTN' in the "SERVICE" field:

```
SERVICE='LwTTN'
```

For the remaining fields:

TTN_URI is the URL from the TTN service to read the uplink response.

Set 'https://integrations.thethingsnetwork.org' as value:

```
TTN_URI='https://integrations.thethingsnetwork.org'
```

TTN_REGION must be a valid LoRaWAN region, these regions are:

- ttn-eu
- ttn-brazil
- ttn-us-west
- ttn-asia-se

For instance, for the European region the field must be 'ttn-eu':

```
TTN_REGION='ttn-eu'
```

"TTN_APP_ID" is the Application ID from the application created on the TTN console. The user can find this value on the "Overview" section. For instance, the Application ID value here is "test_libelium":



Figure : Application ID for "test_libelium" on TTN

```
TTN_APP_ID='test_libelium'
```

"TTN_PROCESS_ID" is displayed on the integration overview configuration. Go to the selected integration and the Process ID is available over the "Integration overview" section. For instance if the Process ID has the value "libelium1234", the configuration will be as follows:



Figure : Process ID on TTN

```
TTN_PROCESS_ID='libelium1234'
```

"TTN_PORT" is the value for the downlink port. This value is available on the device details on the "Downlink" section: navigate to the "Devices" section, click on the wanted device and scroll down until the "Downlink" section. For instance, in the image the "FPort" value is 1, the configuration must be as follows:



Figure : Downlink port for device on TTN

```
TTN_PORT=1
```

“TTN_KEY” appears at the bottom of the “Application overview” section on Access Keys. Click on the copy icon to get the key. This key is a long hexadecimal string. For instance if the key is “ttn-account-v2.HlR_fV9YsXE8GTzFVEP-Byr”, the configuration will be:



Figure : Access Key for “test_libelium” on TTN

```
TTN_KEY='ttn-account-v2.HlR_fV9YsXE8GTzFVEP-Byr'
```

Finally if we gather all parameters, the configuration will be set as follows:

```
TTN_URI='https://integrations.thethingsnetwork.org'
TTN_REGION='ttn-eu'
TTN_APP_ID='test_libelium'
TTN_PROCESS_ID='libelium1234'
TTN_PORT=1
TTN_KEY='ttn-account-v2.HlR_fV9YsXE8GTzFVEP-Byr'
```

7.3.4. How to configure The Things Industries (TTI)

Write 'LwTTI' in the “SERVICE” field:

```
SERVICE='LwTTI'
```

For the remaining fields:

“TTI_URI” is the URL from the TTI service to read the uplink response.

Set the URL value provided from TTI. It should be: *https://integrations.YOUR_COMPANY.thethings.industries*

```
TTI_URI='https://integrations.YOUR_COMPANY.thethings.industries'
```

“TTI_APP_ID” is the Application ID from the application created on the TTI console. The user can find this value on the “Overview” section. For instance, the Application ID value here is “test_libelium”:



Figure : Application ID for "test_libelium" on TTI

```
TTI_APP_ID='test_libelium'
```

"TTI_PROCESS_ID" is displayed on the integration overview configuration. Go to the selected integration and the Process ID is available over the "Integration overview" section. For instance if the Process ID has the value "libelium1234", the configuration will be as follows:



Figure : Process ID on TTI

```
TTI_PROCESS_ID='libelium1234'
```

"TTI_PORT" is the value for the downlink port. This value is available on the device details on the "Downlink" section: navigate to the "Devices" section, click on the wanted device and scroll down until the "Downlink" section. For instance, in the image the "FPort" value is 1, the configuration must be as follows:



Figure : Downlink port for device on TTI

```
TTI_PORT=1
```

"TTI_KEY" appears at the bottom of the "Application overview" section on Access Keys. Click on the "copy" icon to get the key, this key is a long hexadecimal string. For instance if the key is "ttn-account-v2.HIR_fV9YsXE8GTzFVEP-Byr", the configuration will be:



Figure : Access Key for “test_libelium” on TTI

```
TTI_KEY='ttn-account-v2.HlR_fV9YsXE8GTzFVEP-Byr'
```

Finally if we gather all parameters, the configuration will be set as follows:

```
TTI_URI='https://integrations.YOUR_COMPANY.thethings.industries'
TTI_APP_ID='test_libelium'
TTI_PROCESS_ID='libelium1234'
TTI_PORT=1
TTI_KEY='ttn-account-v2.HlR_fV9YsXE8GTzFVEP-Byr'
```

7.3.5. How to configure a MultiTech basestation

Write 'Multitech' in the “SERVICE” field:

```
SERVICE='Multitech'
```

“MTT_USERNAME” is the username that you use as a user to access the configuration panel of the MultiTech basestation:

```
MTT_USERNAME='admin'
```

“MTT_PASSWORD” is the password that you use (with your username) to access the configuration panel of the MultiTech basestation:

```
MTT_PASSWORD='admin1234'
```

“MTT_URI” is the URL where you have configured your MultiTech basestation. By default, the URL to access the MultiTech basestation panel is: “https://192.168.2.1”:

```
MTT_URI='https://192.168.2.1'
```

Finally if we gather all parameters, the configuration will be set as follows:

```
MTT_USERNAME='admin'
MTT_PASSWORD='admin1234'
MTT_URI='https://192.168.2.1'
```

7.4. Making the server accessible from anywhere

7.4.1. Configuring a domain pointing to the customer server

Optimal deployment includes a server name pointing to a public and static IP. Using dynamic DNS could be done with services like no-ip, which has a free package (see <http://www.noip.com/>). No-ip has also a client application responsible for updating any IP address changes in the background (for more information go to <http://www.noip.com/download>).

Finally, the URL to be configured in the LoRaWAN Network Server must be created concatenating the server name and the paths:

Loriot: https://my_server.com/api/parking/v2/services/loriot

Actility: https://my_server.com/api/parking/v2/services/actility

TTN (The Things Network): https://my_server.com/api/parking/v2/services/ttn

TTI (The Things Industries): https://my_server.com/api/parking/v2/services/tti

MultiTech (MultiTech basestation): https://my_server.com/api/parking/v2/services/multitech

7.5. Remote Configuration Form

The Remote Configuration Form is a web application which permits to update some node parameters (sensor and timing parameters). This is done thanks to the OTA-S (Over-The-Air-Setup) functionality. The update is done remotely via LoRaWAN downlink packets. LoRaWAN parameters cannot be updated with the Remote Configuration Form.

For accessing the Remote Configuration Form, log in with your user and password from your SCM account. Enter your credentials and press "Login".

LOGIN INTO THE LIBELIUM CLOUD

User:

systems@libelium.com

Password:

●●●●●●●●

Login

Figure : User login

Select one or several devices on the drop-down menu. Each device is identified by their unique LoRaWAN EUI. The nodes displayed in the drop-down menu correspond to the nodes you have claimed for on your SCM account. You can also deselect previously selected nodes using the cross icon.

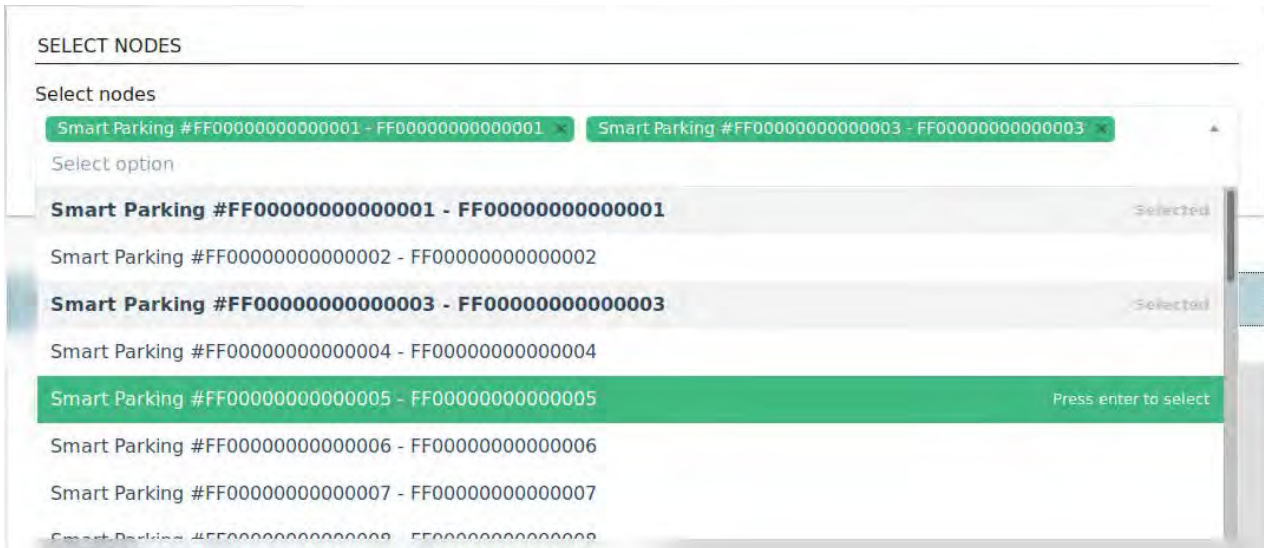


Figure : Smart Parking node selection

Once a node is selected, its current configuration is displayed and you can modify it. For further information of the node parameters, please refer to the chapter [“Smart Parking node”](#).

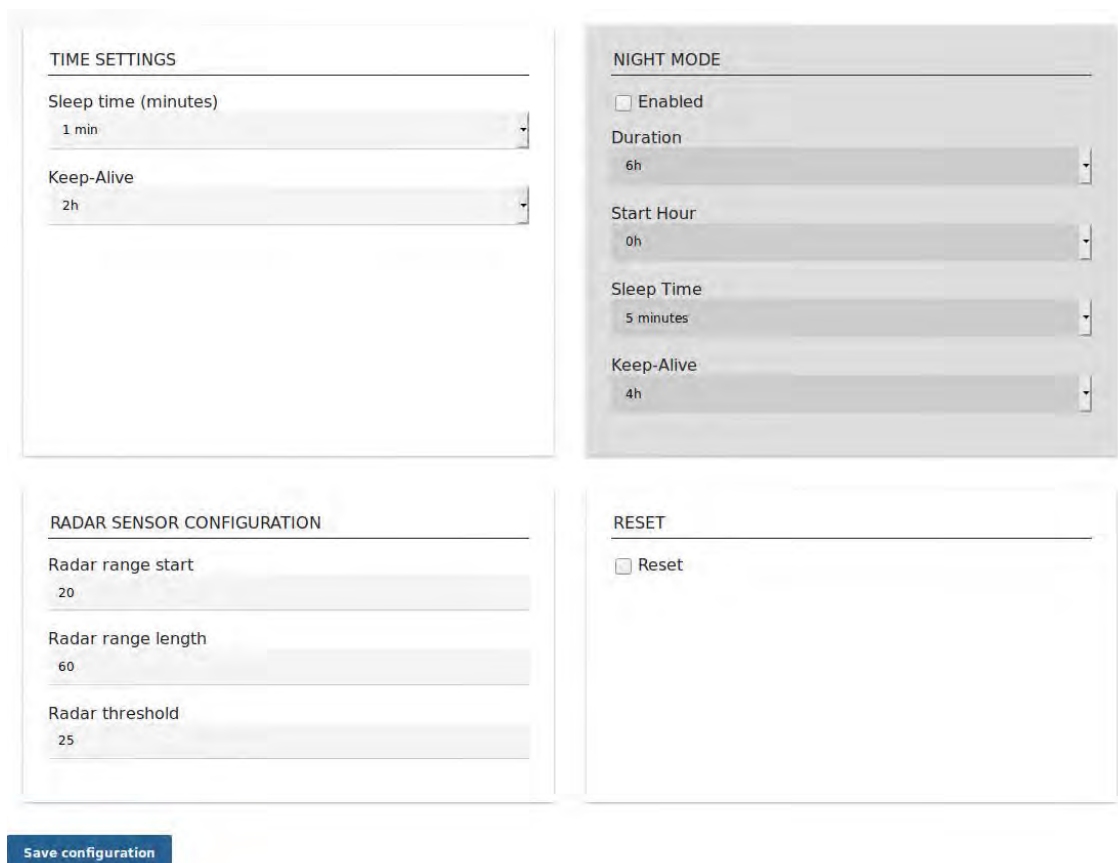


Figure : Smart Parking node configuration

Once you have configured the node or nodes, press the “Save configuration” button. A message is shown indicating that a downlink frame with the node’s configuration has been enqueued on the downlink queue of the LoRaWAN Network Server. Therefore, the node will receive a downlink frame with the new configuration in response to the next Info frame or Keep Alive frame.

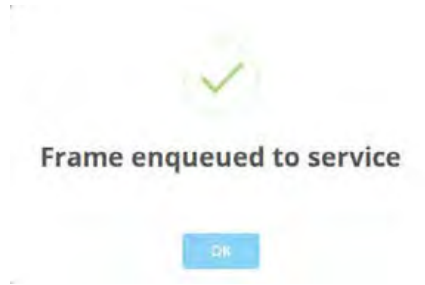


Figure : Frame enqueued for processing

So the Remote Configuration Form application allows the user to update some node parameters, just as the Smart Devices App does. However, using the Smart Devices App requires physical access to the Smart Parking node: the node must be plugged to a computer with a USB cable.

Note: The Remote Configuration Form does not permit to update any LoRaWAN parameter. The Smart Devices App should be used instead.

7.6. Customer Server Core

The Customer Server Core deals with the LoRaWAN Network Server requests delivering the proper replies if needed. When it receives a new uplink frame, it parses its data to identify all fields and perform adequate operations. By default, the source code is prepared to insert the parsed data into a MySQL database.

Regarding the frame type, if a "Start Frame 1" or "RTC Update Request" frames are received, then a new downlink frame is immediately enqueued into the LoRaWAN Network Server with the proper answer.

On the other hand, when the Remote Configuration Form is managed in order to update node parameters, a downlink frame is sent to the LoRaWAN Network Server with the new values.

For further information about the different frame types please refer to the "[Frame types](#)" section.

7.6.1. End-point

Once you have installed and configured the Customer Server, the system will be prepared to listen to LoRaWAN requests. The end-point will vary depending on the configured LoRaWAN service. By default, the source code is prepared for all the officially supported network servers (Loriot, Actility, TTN, etc).

7.6.2. Data Parser

The Data Parser will unpack the payload data sent by the node before the insertion on the database. It will also prepare the proper response to the LoRaWAN Network Server if needed.

7.6.3. Database

The Customer Server Core inserts data into a MySQL database upon uplink frames arrival. The uplink frames are parsed by the Data Parser and the source code is capable of performing smart database insertions by accessing to previously stored information. For example, a loss in the sequence number is calculated by reading the previous sequence number insertion. Besides, the node time settings (Sleep time, Keep Alive time, etc) are stored since the "Start frame 1" and "Start frame 2" are received so it is possible to access to the current node configuration any time.

The structure of the database provided is:

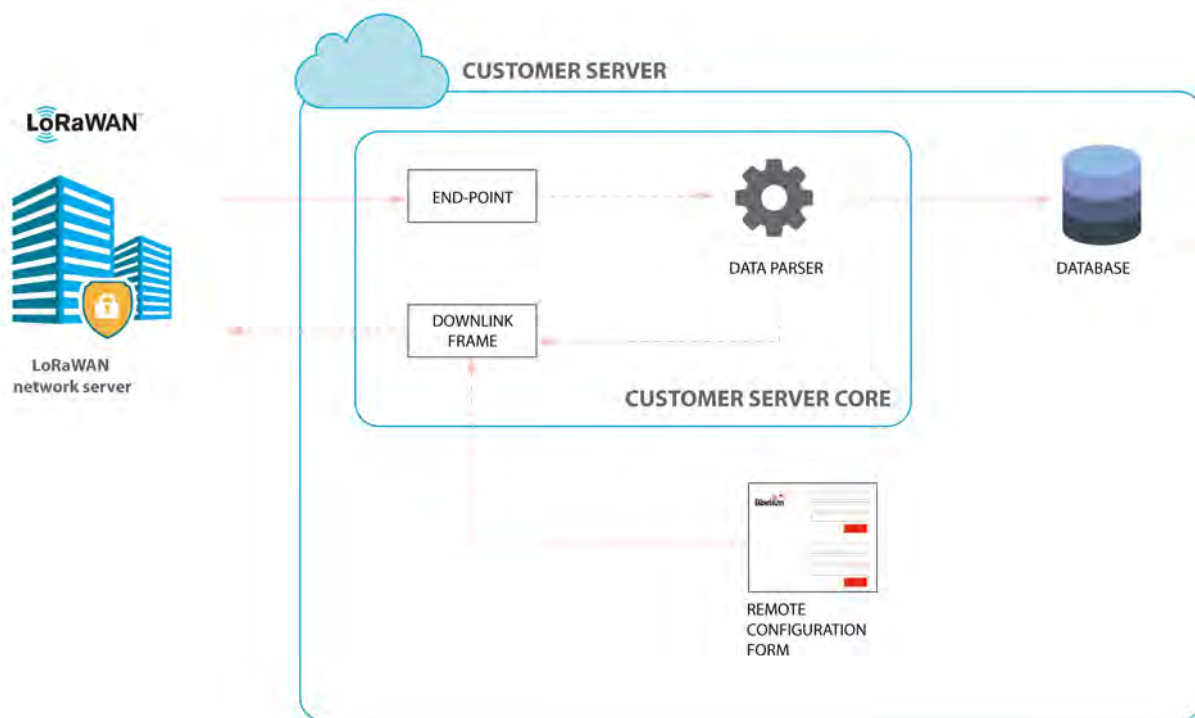


Figure : Customer Server Core

Database Field	Field updated by	Description
LW_EUI	All uplink frames	The node's unique LoRaWAN EUI.
LW_ts	All uplink frames	The uplink frame timestamp.
LW_up_counter	All uplink frames	The LoRaWAN protocol uplink counter. This field belongs to the link level. Range: from 0 to 4294967295.
LW_port	All uplink frames	The LoRaWAN port used to send the data. Range: from 1 to 223.
LW_rssi	All uplink frames	The uplink "Received Signal Strength Indication" (dBm).
LW_dr	All uplink frames	The uplink frame datarate.
LW_uplink	All uplink frames	The uplink frame contents in HEX digits.
LW_downlink	All uplink frames	The enqueued downlink frame in response to the uplink received. The contents in HEX digits. Normally this field is empty.
frame_type_uplink	All uplink frames	The frame type of the received uplink frame.
parking_slot_status	Info, Keep-alive, RTC update	The status of the parking lot (0: free; 1: occupied).
battery_state	All uplink frames	The battery state of the node (0: OK; 1: warning).
recalibration	All uplink frames	Flag to indicate sensor recalibration since last uplink (0: no; 1: yes).
sequence_number	All uplink frames	The application level sequence number. This field belongs to the frame contents. Range: from 0 to 255.

lost_up_counter (*)	All uplink frames	Field to indicate the loss of a LoRaWAN protocol sequence number.
lost_seq (*)	All uplink frames	Field to indicate the loss of an application sequence number.
sensor_error	Info, Keep-alive, RTC update	Field to indicate an error in sensor management (0: no error).
temperature	Info, Keep-alive, RTC update	The temperature value (Celsius degrees).
time_hh	Info, Keep-alive, RTC update	The node's RTC timestamp (hours field).
time_mm	Info, Keep-alive, RTC update	The node's RTC timestamp (minutes field).
distance	Info, Keep-alive, RTC update	The distance to an object provided by the sensor reading (mm units).
amplitude	Info, Keep-alive, RTC update	The amplitude of the object reflection provided by the sensor reading (no units).
n_reflections	Info	Number of reflections in sensor reading. The first reflection (most important one) is related to amplitude and distance values.
battery	Keep-alive, RTC update	The battery level read by the node (mV units).
radar_threshold	Start frame 1	The threshold configured to the radar sensor.
radar_range_start	Start frame 1	The starting range configured to the radar sensor (mm units).
radar_range_length	Start frame 1	The length of range configured to the radar sensor (mm units).
firmware_version	Start frame 1	The number related to firmware version.
sleep_time_minutes	Start frame 2	Time settings related to sleep time minutes field.
sleep_time_seconds	Start frame 2	Time settings related to sleep time seconds field.
keep_alive	Start frame 2	Time settings related to Keep-alive time field (hours field except for 0.5h which is equal to zero).
nm	Start frame 2	Field to indicate if night-mode is active (0: disabled; 1: enabled).
nm_start_hour	Start frame 2	Field to indicate when night-mode starts (hours field).
nm_duration	Start frame 2	Field to indicate night-mode duration (hours field).
nm_sleep_time	Start frame 2	Field to indicate night-mode sleep time (minutes field).
nm_keep_alive	Start frame 2	Field to indicate night-mode Keep-alive time (hours field).

(*) Fields calculated by the Data Parser by accessing to previous database insertions.

For further information about the fields please refer to the "[Frame types](#)" chapter.

The next figure shows a fragment of the table on the database where data was inserted for a specific LoRaWAN EUI:

id	LW_EUI	LW_Is	LW_up_counter	LW_port	LW_rssi	LW_sr	LW_uplink	LW_downlink	frame_type_uplink	parking_slot_status	battery_state	recalibration	sequence_number	sensor_error	temperature
24801	0004A30B00288390	2019-04-30 08:27:07	550	3	-89	SF10 BW125 4/5	81260000001b01504000d9		1	1	0	0	38	0	11
24802	0004A30B00288390	2019-04-30 07:57:08	548	3	-88	SF10 BW125 4/5	812500000073801803A034		1	1	0	0	37	0	10
24872	0004A30B00288390	2019-04-30 07:27:02	546	3	-91	SF10 BW125 4/5	812400000071a01c0413004		1	1	0	0	36	0	11
24801	0004A30B00288390	2019-04-30 06:56:50	547	3	-90	SF10 BW125 4/5	8123000000538018541b0314		1	1	0	0	35	0	10
24846	0004A30B00288390	2019-04-30 06:26:57	546	3	-97	SF10 BW125 4/5	802200000061a00e53ec005		0	1	0	0	34	0	9
24911	0004A30B00288390	2019-04-30 06:02:57	543	3	-71	SF10 BW125 4/5	012100000000200000000a7		1	0	0	0	33	0	9
24823	0004A30B00288390	2019-04-30 05:32:54	544	3	-79	SF10 BW125 4/5	01200000000520000000004		1	0	0	0	32	0	9
24808	0004A30B00288390	2019-04-30 05:32:53	543	3	-76	SF10 BW125 4/5	0110000000000000000004		1	0	0	0	31	0	10
24854	0004A30B00288390	2019-04-30 05:32:51	542	3	-78	SF10 BW125 4/5	011e00000120000000000a5		1	0	0	0	30	0	11
24800	0004A30B00288390	2019-04-30 22:32:50	541	3	-77	SF10 BW125 4/5	011a000c1720000000000d3		1	0	0	0	29	0	12
24865	0004A30B00288390	2019-04-29 21:32:48	540	3	-61	SF10 BW125 4/5	011c000e1520000000000a4		1	0	0	0	28	0	14
24853	0004A30B00288390	2019-04-29 21:02:46	539	3	-70	SF10 BW125 4/5	011a080f1520000000000c7		1	0	0	0	27	0	15
24839	0004A30B00288390	2019-04-29 20:32:43	538	3	-81	SF10 BW125 4/5	011a000f1420000000000c7		1	0	0	0	26	0	15
24827	0004A30B00288390	2019-04-29 20:02:41	537	3	-76	SF10 BW125 4/5	0119000f1402000000000c7		1	0	0	0	25	0	15
24813	0004A30B00288390	2019-04-29 19:32:38	536	3	-78	SF10 BW125 4/5	01180010120000000000c7		1	0	0	0	24	0	16
24801	0004A30B00288390	2019-04-29 19:02:35	535	3	-77	SF10 BW125 4/5	011700111502000000000c7		1	0	0	0	23	0	17
24887	0004A30B00288390	2019-04-29 18:32:33	534	3	-78	SF10 BW125 4/5	01160011120000000000c7		1	0	0	0	22	0	17
24875	0004A30B00288390	2019-04-29 18:02:30	533	3	-76	SF10 BW125 4/5	01150012120000000000c7		1	0	0	0	21	0	18
24861	0004A30B00288390	2019-04-29 17:32:27	532	3	-77	SF10 BW125 4/5	01140012112000000000c7		1	0	0	0	20	0	18
24849	0004A30B00288390	2019-04-29 17:02:25	531	3	-60	SF10 BW125 4/5	01130012110000000000c7		1	0	0	0	19	0	18
24835	0004A30B00288390	2019-04-29 16:32:22	530	3	-78	SF10 BW125 4/5	01120012102000000000c7		1	0	0	0	18	0	18
24816	0004A30B00288390	2019-04-29 16:02:20	529	3	-77	SF10 BW125 4/5	00110011100200000000000		0	0	0	0	17	0	17
24815	0004A30B00288390	2019-04-29 15:57:16	528	3	-95	SF10 BW125 4/5	87100011003012c27e8c7 0003030		7	1	0	0	16	0	17
24814	0004A30B00288390	2019-04-29 15:57:10	527	3	-89	SF10 BW125 4/5	87060011003012c27e8c7 0003030		7	1	0	0	15	0	17
24800	0004A30B00288390	2019-04-29 15:49:03	526	3	-83	SF10 BW125 4/5	81080011002701242890c7		1	1	0	0	14	0	17

Figure : Database table example

Once data is stored on the database, you can use any compatible tool to query the database and develop your own data analysis and visualization. This task belongs entirely to the customer or system integrator.

Last packet received				
node_name =	LW_EUI	Time	Frame_type	State
node_01	0004A30B00288390	2019-04-30 10:57:10	Keep alive	OCCUPIED
node_02	0004A30B00286556	2019-04-30 11:00:19	Keep alive	OCCUPIED
node_03	0004A30B0028A38A	2019-04-30 11:07:40	Keep alive	OCCUPIED
node_04	0004A30B00287F04	2019-04-30 11:00:01	Keep alive	OCCUPIED
node_05	0004A30B00287F01	2019-04-30 10:56:10	Keep alive	FREE
node_06	0004A30B0028600B	2019-04-30 11:20:00	Keep alive	FREE
node_07	0004A30B002612F1	2019-04-30 11:10:41	Keep alive	OCCUPIED
node_08	0004A30B0026425C	2019-04-30 11:02:57	Keep alive	OCCUPIED
node_09	0004A30B00268D81	2019-04-30 11:04:18	Keep alive	OCCUPIED
node_10	0004A30B0025EE61	2019-04-30 10:55:43	Keep alive	OCCUPIED
node_11	0004A30B002680BD	2019-04-30 11:01:36	Keep alive	OCCUPIED

Figure : Example of database visualization using Grafana (basic open-source application)

7.7. Modifying the Customer Server

Maybe you want to modify the Customer Server to match your requirements, this section describes the best way to do it.

7.7.1. Extracting data from the Customer Server

Every time a frame is received by the Customer Server, an event is created. You can take advantage of this event to send the passed data to any external service. To do this, you have to edit the file "src/app/Listeners/FrameListener.php". This file receives the data parsed in the variable "\$event->frame". This variable contains 4 objects: input (with the frame received parsed), lw (with the information sent by the Network Server), node (with information about the node) and output (with the downlink frame enqueued on the service, if

needed).

On that file you can find a commented example of a URL request; you can modify and adapt it to your needs.

7.7.2. Modifying the Database

If you want to use a database which is different to the provided one, or if you want to change the way data is saved on the database, you must modify the file `src/app/Helpers/DataFlow.php`.

This class has 3 methods:

- **get_null_record**: This method should return an array of **NULL** values foreach field defined on the database.
- **get_last_record**: This method should return the previous record for the device. It should call the previous method if there isn't any previous value for the node.
- **insert_record**: This method receives the data prepared to be inserted on the database as input and therefore it makes the database insertion on a new row.

7.7.3. Adding a new unsupported LoRaWAN Network Server

To add a new LoRaWAN Network Server (different from the officially supported by Libelium) you have to create a new PHP class that must implement the interface located on `src/app/Helpers/Services/LwServiceInterface.php`. There are 4 methods to be implemented:

- **enqueue_message**: It allows to send data to the new LoRaWAN Network Server.
- **get_lw_info_from_request**: It returns all the LoRaWAN information from the request of the new LoRaWAN Network Server.
- **get_eui_from_request**: It returns the node EUI from the request of the new LoRaWAN Network Server.
- **get_payload_from_request**: It returns the payload from the request of the new LoRaWAN Network Server.

The next step would be to create an endpoint to be able to receive data from the LoRaWAN Network Server. Therefore, you have to create a new method on the services app's controller:

```
src/app/Http/Controllers/api/v2/ServiceController.php
```

This method will receive a request object with all the data provided from the service, you can use the helper methods from the service class you have created previously. The implementation details can vary from service to service, so this cannot be explained in detail (you can use the Lorient and Activity ones as a reference).

The functionality that this method must implement is:

- Get data from the request
- Parse the payload using the same helper class used by the provided services:

```
$a_result = $this->frames->main($EUI, $payload);
```

- Enqueue the data if the parser returns something on the **output** key returned from the parser:

```

if($a_result['output']){
    YourService::enqueue_message($EUI, $a_result['output']['data']);
}

```

- Optionally, trigger an event to save the transaction to the database:

```

event(new \App\Events\DecoderEvent($a_result));

```

Once all steps have been completed you have to register the service on the file:

```

src/app/Providers/AppServiceProvider.php

```

The register method should pair LwService with the service you have just created.

7.8. Upgrading the Customer Server

If you want to upgrade the Customer Server you need to download the new version from the link provided by our Sales Team (sales@libelium.com) and uncompress the files to a new folder. For example:

Old version:

```

/path/to/old/smart-parking-customer-server/

```

New version:

```

/path/to/new/smart-parking-customer-server-new/

```

Then you can use the "diff" command to create a file to patch your old and functioning version of the Customer Server. The command to execute is:

```

diff -Nur \
/path/to/old/smart-parking-customer-server/ \
/path/to/new/smart-parking-customer-server-new/ \
> /path/to/upgrade.diff

```

Note: You can ignore the warnings about the permissions of the files contained on "bin/ci/smart_parking/mysql-data".

Once the diff is generated, you should use the generated file (/path/to/upgrade.diff) to check which files are going to be created or modified. The following commands will show a list of the files to be modified:

```

cd /path/to/old/smart-parking-customer-server/
patch -p0 --dry-run < /path/to/upgrade.diff

```

If you have not modified any of these files with your own developments, you can apply the patch like this:

```
cd /path/to/old/smart-parking-customer-server/  
patch -p0 < /path/to/upgrade.diff
```

Note: You can also add the flag '-b' to the "patch" command to create a backup of each modified file. Once the patch process is completed, you will have to review your ".env" file and add the new options that you can find in the patched ".env.example" file.

8. Libelium Smart Parking Cloud Service

You can use the Libelium Smart Parking Cloud Service to configure your nodes and to receive data from them. Using the Smart Parking Cloud Service, you do not need any software infrastructure on your side, you just need to purchase a Smart Parking Cloud Service license.

The Smart Parking Cloud Service can be understood as one of the services that we offer on our Libelium Cloud (officially called Services Cloud Manager - SCM). Other services hosted on the SCM are the Programming Cloud Service or the Bridge. The SCM permits devices management and allows access to the different services.

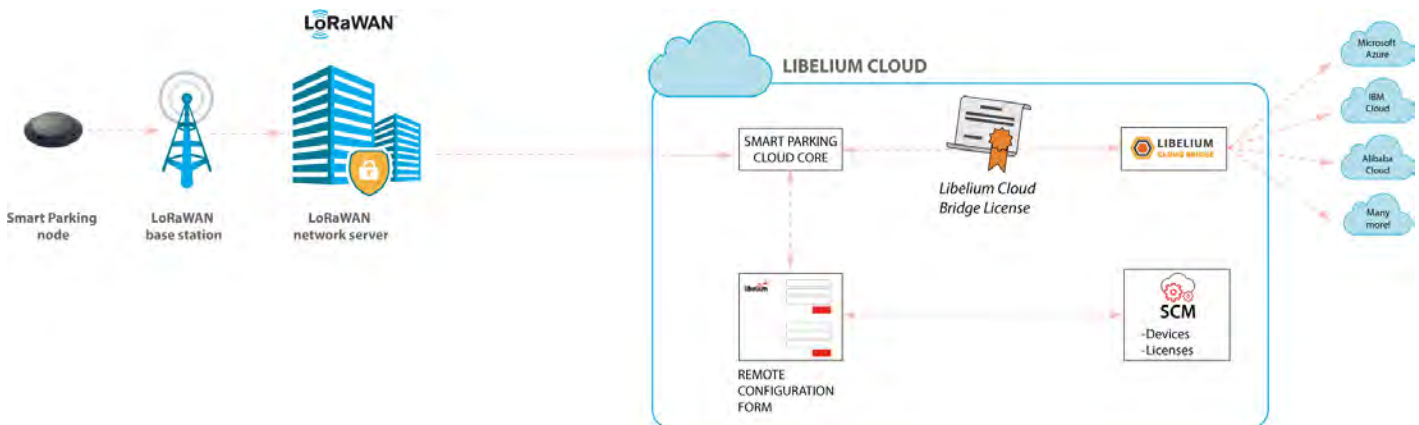


Figure : Smart Parking Cloud Service

The Smart Parking Cloud Service includes the Remote Configuration Form to manage the configuration values of the Smart Parking nodes, and the Smart Parking Cloud Core, that deals with the LoRaWAN network server requests, sending back a response if needed. The data sent from the Smart Parking nodes will be sent to any compatible final IoT cloud service (Amazon, Azure, etc) using the Libelium Bridge (you will need a [license to use the Bridge](#)).

8.1. Smart Parking Cloud Service

Once logged on the Services Cloud Manager, users can access the Smart Parking Cloud Service by clicking on the “Smart Parking” button on the left-side menu under the “Services” section. A valid licence is compulsory in order to work with this service.



Figure : Accessing the Smart Parking Cloud Service (1st way)

Another way to access the Smart Parking Cloud Service is through the collapsed menu at the top right of the Services Cloud Manager. Clicking on it and then on the “Smart Parking” option, users will arrive to the same place. As in the previous case, users must own a valid license. Otherwise, this option will not be displayed.



Figure : Accessing the Smart Parking Cloud Service (2nd way)

Once the user has a valid license, the following features will be available accessing the Smart Parking Cloud Service: configure nodes remotely, configure the LoRaWAN service, check the logs for the configured service and generate the tokens and keys needed for the LoRaWAN network server.

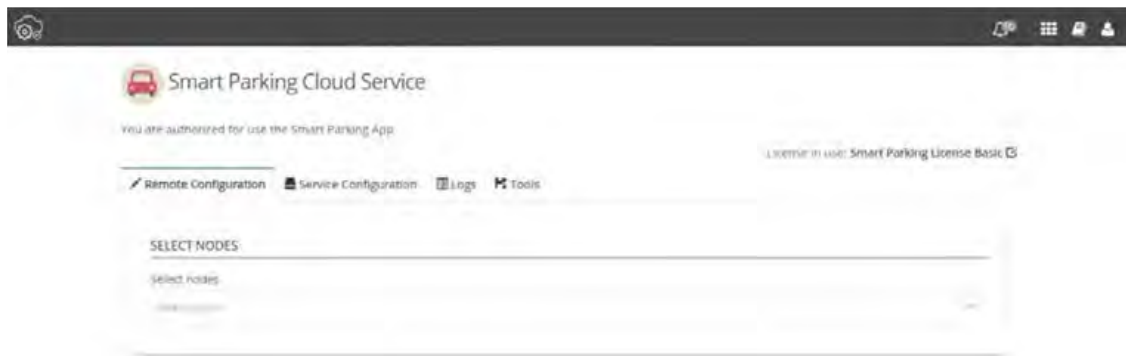
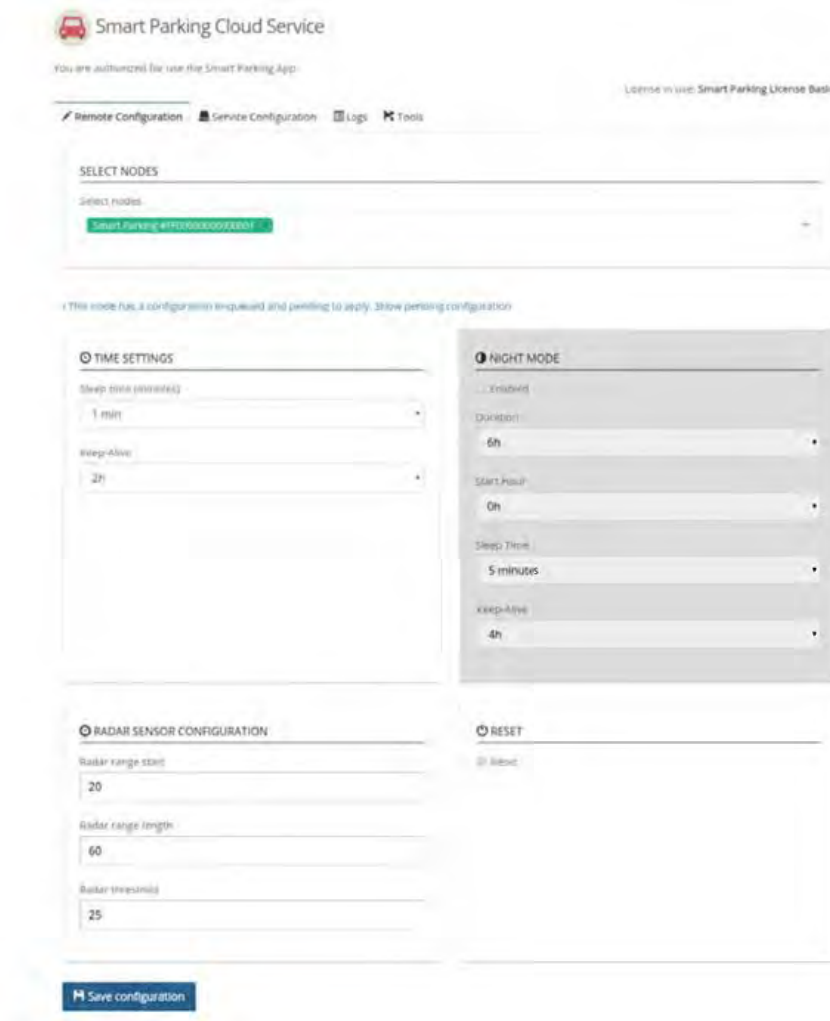


Figure : Smart Parking Cloud Service landing page

8.1.1. Remote configuration

This tab shows a drop-down menu to select one or several devices. Each one is identified by their unique LoRaWAN EUI. The nodes displayed in the drop-down menu correspond to the nodes you have claimed for on your Services Cloud Manager account. You can also deselect previously selected nodes using the cross in the node's identification. Once a node is selected, the current configuration of this node is displayed and you can modify it. For further information of the displayed node parameters, please refer to the chapter "[Smart Parking node](#)".



The screenshot shows the 'Smart Parking Cloud Service' interface. At the top, it says 'You are authorized for use for Smart Parking App.' and 'License in use: Smart Parking License Basic'. Below this are tabs for 'Remote Configuration', 'Service Configuration', 'Logs', and 'Tools'. The 'Remote Configuration' tab is active, showing a 'SELECT NODES' section with a dropdown menu. Below this is a message: 'This node has a configuration enqueued and pending to apply. Show pending configuration'. The main configuration area is divided into four sections: 'TIME SETTINGS', 'NIGHT MODE', 'RADAR SENSOR CONFIGURATION', and 'RESET'. The 'TIME SETTINGS' section has 'Sleep time (minutes)' set to '1 min' and 'Keep-Alive' set to '2h'. The 'NIGHT MODE' section has 'Enabled' checked, 'Duration' set to '6h', 'Start hour' set to '0h', 'Sleep Time' set to '5 minutes', and 'Keep-Alive' set to '4h'. The 'RADAR SENSOR CONFIGURATION' section has 'Radar range start' set to '20', 'Radar range length' set to '60', and 'Radar threshold' set to '25'. The 'RESET' section has a 'Reset' button. At the bottom, there is a 'Save configuration' button.

Figure : Remote Configuration Form

Once you have configured the node(s) and the service as explained in the section “[Service configuration](#)”, press the “Save configuration” button. A message indicates that a downlink frame with the node’s configuration has been enqueued to the LoRaWAN Network Server downlink queue. The node will receive a downlink frame with the new configuration in response to the next Info or Keep-Alive uplink frame.

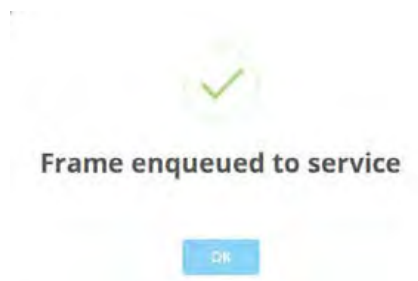


Figure : Frame enqueued for processing

The Remote Configuration Form application allows the user to update some node parameters just as the Smart Devices App does. However, using the Smart Devices App requires physical access to the node: it must be plugged to your computer via a USB cable.

Note: The Remote Configuration Form does not permit to update any LoRaWAN parameter. The Smart Devices App should be used instead.

8.1.2. Service configuration

The Smart Parking Cloud Service is compatible with the following LoRaWAN Network Servers: Lorient, Activity, The Things Network (TTN), The Things Industries (TTI) and the Embedded Network Server inside MultiTech basestations.

These are the URLs to be configured on the LoRaWAN Network Server:

Lorient: <https://api.libelium.com/cloud/parking/v2/services/loriot>

Activity: <https://api.libelium.com/cloud/parking/v2/services/activity>

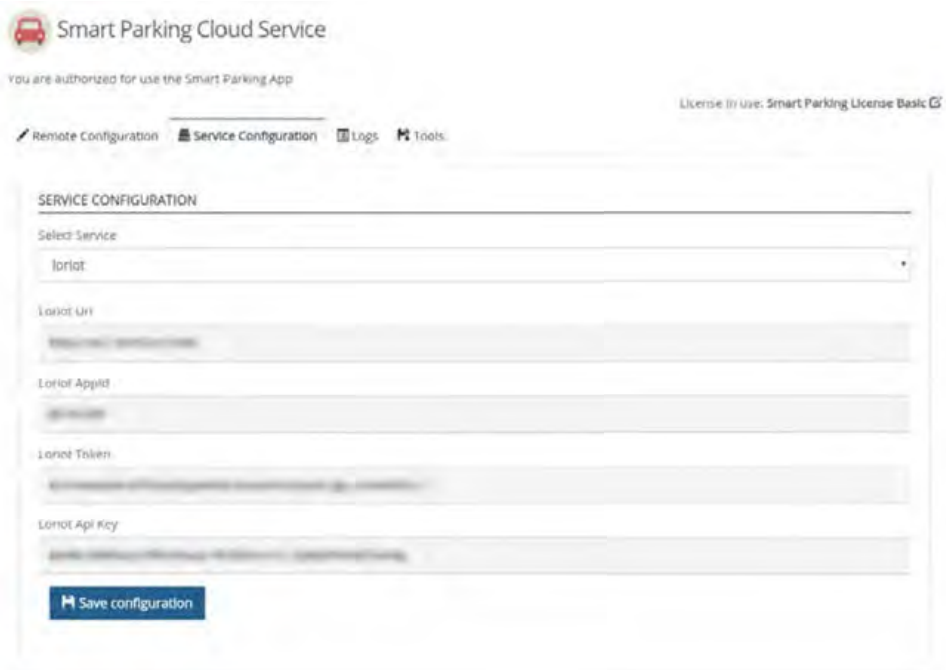
TTN: <https://api.libelium.com/cloud/parking/v2/services/ttn>

TTI: <https://api.libelium.com/cloud/parking/v2/services/tti>

MultiTech: <https://api.libelium.com/cloud/parking/v2/services/multitech>

Note: Only one of these services can be active at the same time.

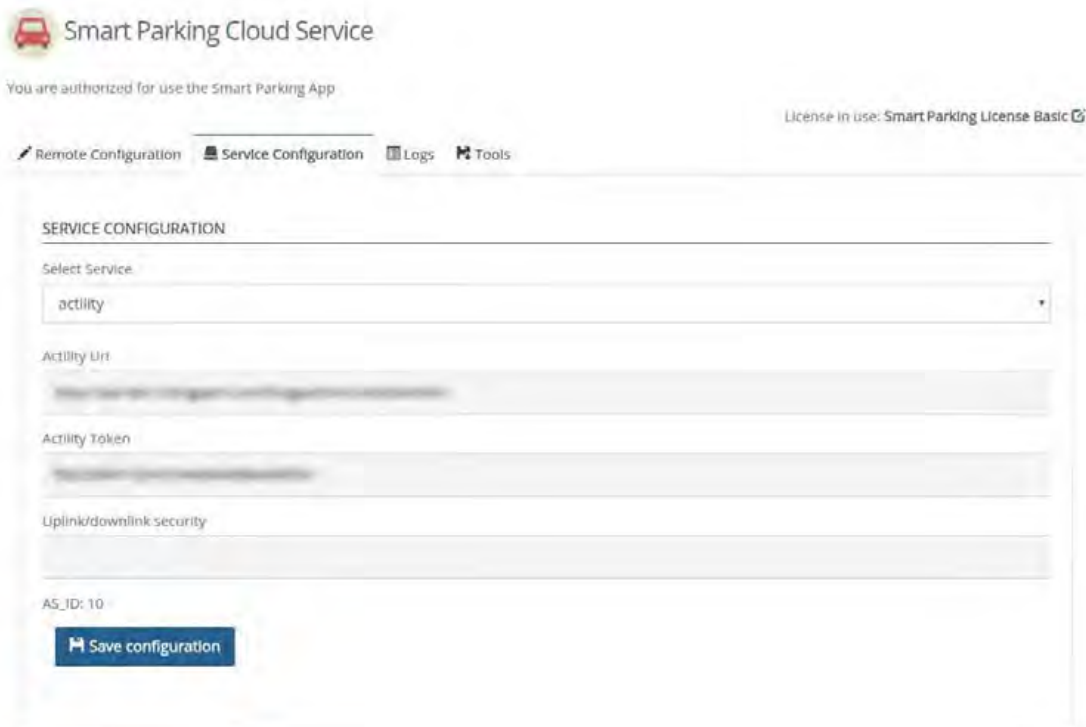
If you want to use Lorient as your LoRaWAN Network Server, you have to select it on the drop-down menu and complete the required fields. To find the information on the Lorient panel, you can follow the instructions described on the ["How to configure Lorient"](#) section.



The screenshot shows the 'Smart Parking Cloud Service' configuration page. At the top, it says 'You are authorized to use the Smart Parking App' and 'License By use: Smart Parking License Basic'. Below this are tabs for 'Remote Configuration', 'Service Configuration' (which is active), 'Logs', and 'Tools'. The 'SERVICE CONFIGURATION' section contains a 'Select Service' dropdown menu with 'loriot' selected. Below this are input fields for 'Lorient URI', 'Lorient AppId', 'Lorient Token', and 'Lorient Api Key'. Each field has a placeholder text. At the bottom of the configuration section is a blue button labeled 'Save configuration'.

Figure : Lorient configuration

If you want to use Activity as your LoRaWAN Network Server, you have to select it on the drop-down menu and complete the required fields. To find the information on the Activity panel, you can follow the instructions described on the ["How to configure Activity"](#) section.



Smart Parking Cloud Service

You are authorized for use the Smart Parking App

License in use: Smart Parking License Basic

Remote Configuration Service Configuration Logs Tools

SERVICE CONFIGURATION

Select Service

activity

Activity Uri

Activity Token

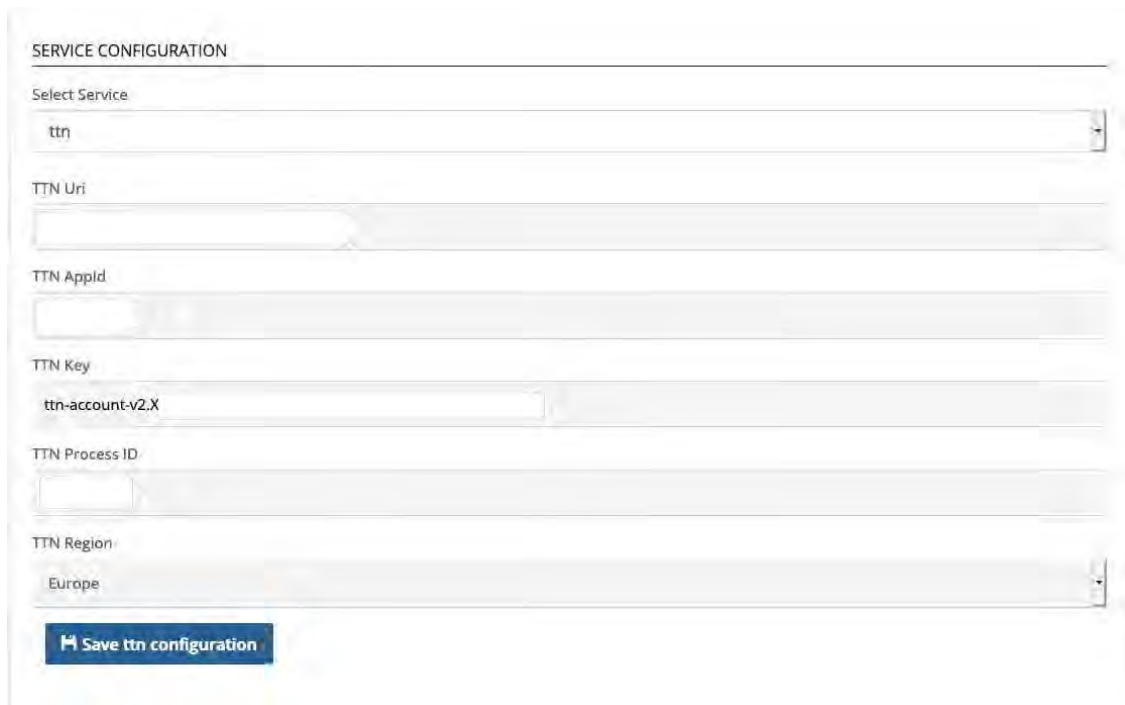
Uplink/downlink security

AS_ID: 10

Save configuration

Figure : Activity configuration

If you want to use TTN as your LoRaWAN Network Server, you have to select it on the drop-down menu and complete the required fields. To find the information on the TTN panel, you can follow the instructions described on the [“How to configure The Things Network \(TTN\)”](#) section.



SERVICE CONFIGURATION

Select Service

ttn

TTN Uri

TTN Appld

TTN Key

ttn-account-v2.X

TTN Process ID

TTN Region

Europe

Save ttn configuration

Figure : TTN configuration

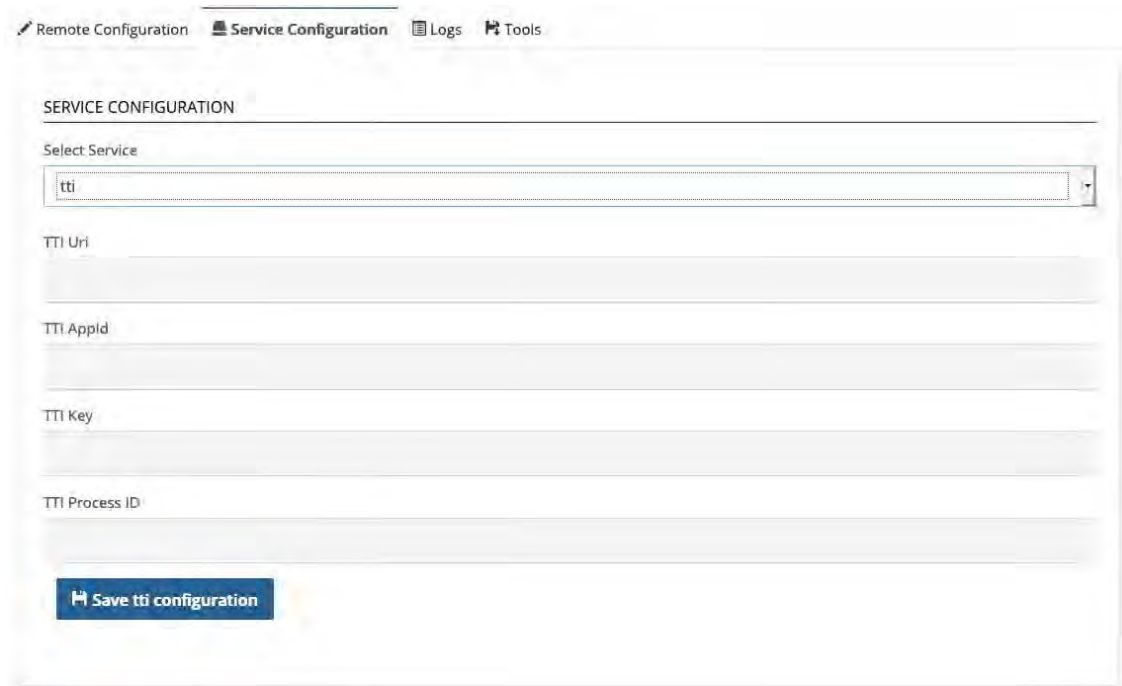
Please, be aware that there are a set of regions to choose, click on the regions dropdown to see all choices. The current regions to send the data are:

- **Europe:** Uses value *ttn-eu*

- **USA:** Uses value *ttn-us-west*
- **Brazil:** Uses value *ttn-brazil*
- **Asia:** Uses value *ttn-asia-se*

For further information about TTN regions, please see [TTN documentation](#).

If you want to use TTI as your LoRaWAN Network Server, you have to select it on the drop-down menu and complete the required fields. To find the information on the TTI panel, you can follow the instructions described on the [“How to configure The Things Industries \(TTI\)”](#) section.



The screenshot shows the 'Service Configuration' tab in the Libelium Smart Parking Cloud Service interface. The 'SERVICE CONFIGURATION' section is active. A dropdown menu labeled 'Select Service' is set to 'tti'. Below this, there are four text input fields labeled 'TTI Uri', 'TTI Appld', 'TTI Key', and 'TTI Process ID'. At the bottom of the configuration section, there is a blue button labeled 'Save tti configuration'.

Figure : TTI configuration

If you want to use the embedded LoRaWAN Network Server inside a MultiTech basestation as your LoRaWAN Network Server, you have to select it on the drop-down menu and complete the required fields. To find the information on the MultiTech basestation panel, you can follow the instructions described on the [“How to configure a MultiTech basestation”](#) section.

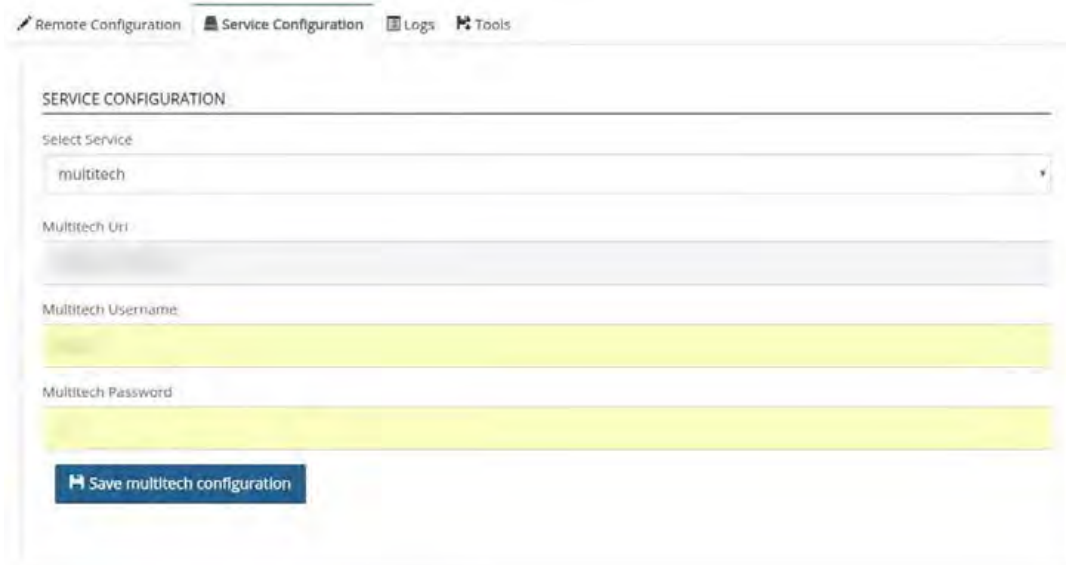


Figure : MultiTech configuration

Regardless of the service you have configured, click the button “Save configuration” to save your LoRaWAN service configuration. Then a message will be displayed indicating that the service has been updated or saved correctly.

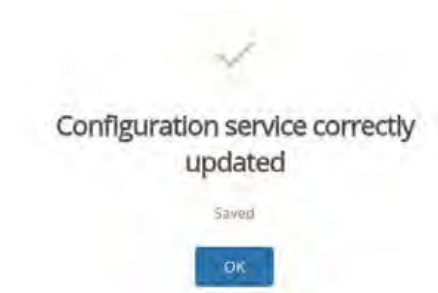


Figure : Service configuration saved

Authentication token for HTTP integration with TTN

The Smart Parking Cloud Service uses tokens for authentication. The user must 1st create a token (an API key) and then use it on TTN.

Perform these steps to create a new API key and set it on TTN:

Step 1: Click “Create new API key” on the “Tools” tab.



Figure : Step 1 - TTN integration

Step 2: Set a name for the new API key and click the “Create” button.



Figure : Step 2 - TTN integration

Step 3: The new API key is shown, copy it.

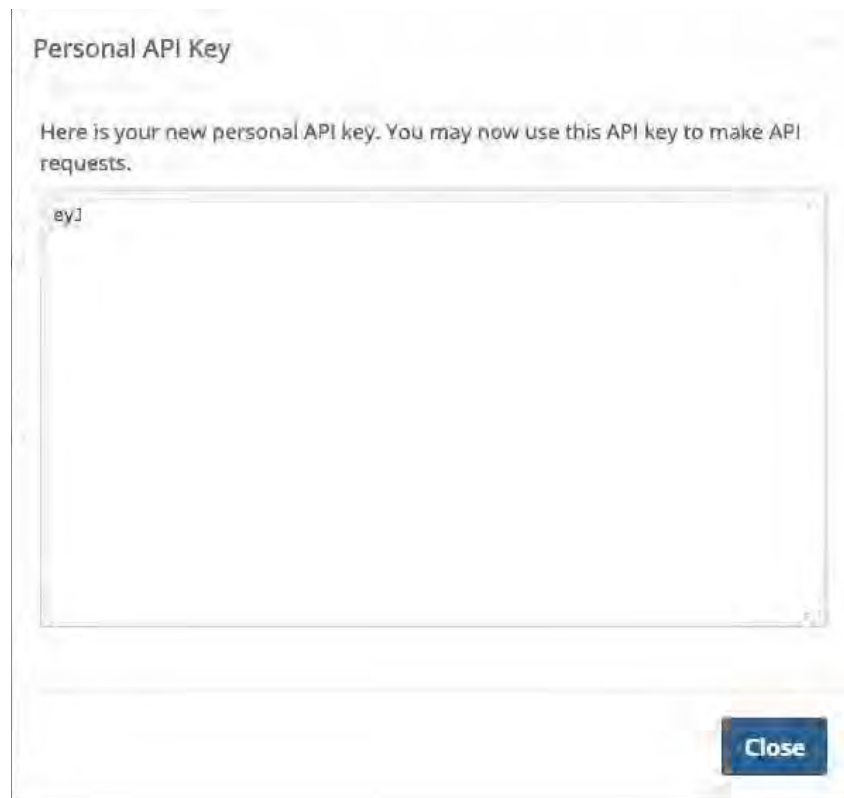


Figure : Step 3 - TTN integration

Step 4: Paste the API key on the “Authorization” field of HTTP TTN integration. This field must have: **Bearer CLOUD_LIBELIUM_TOKEN**.



Method
The HTTP method to use:

POST

Authorization
The value of the Authorization header:

Bearer ey

Figure : Step 4 - Authorization field on TTN HTTP integration

Authentication token for HTTP integration with TTI

The Smart Parking Cloud Service uses tokens for authentication. The user must 1st create a token (an API key) and then use it on TTI.

Perform these steps to create a new API key and set it on TTI:

Step 1: Click "Create new API Key" on the "Tools" tab.



Remote Configuration Service Configuration Logs Tools

DOWNLOAD NODE KEYS

Use this button for download the Node configuration keys to use in the LoRaWAN panels *

Download Node Keys

CONSUMERS Version 1.0.0

Personal API Keys

You have not created any personal API keys.

Create New Api Key

Figure : Step 1 - TTI integration

Step 2: Set a name for the new API key and click the "Create" button.



Create key

Name

TTI

Close Create

Figure : Step 2 - TTI integration

Step 3: The new API key is shown, copy it.

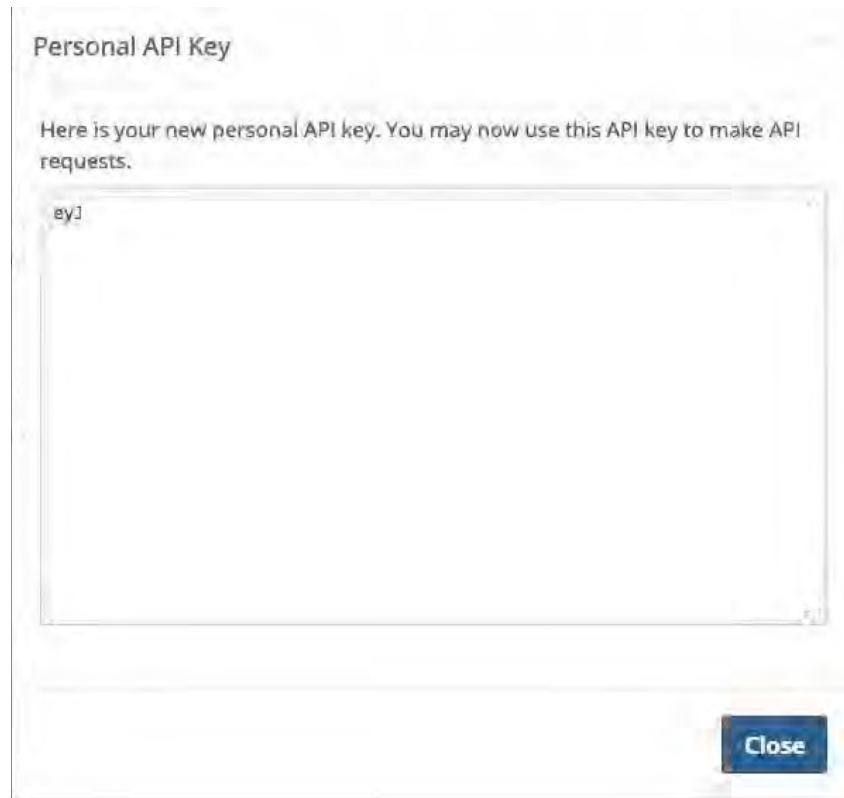


Figure : Step 3 - TTI integration

Step 4: Paste the API key on the “Authorization” field of HTTP TTI integration. This field must have: **Bearer** **CLOUD_LIBELIUM_TOKEN**.



Figure : Step 4 - Authorization field on TTI HTTP integration

Authorization token for integration with MultiTech basestation

The Smart Parking Cloud Service uses tokens for authentication. The user must 1st create a token (an API key) and then use it on the MultiTech basestation.

Perform these steps to create a new API key and set it on the Libelium custom app in the MultiTech basestation:

Step 1: Click “Create new API Key” on the “Tools” tab.



Figure : Step 1 - MultiTech integration

Step 2: Set a name for the new API key and click the “Create” button.



Figure : Step 2 - MultiTech integration

Step 3: The new API key is shown, copy it.

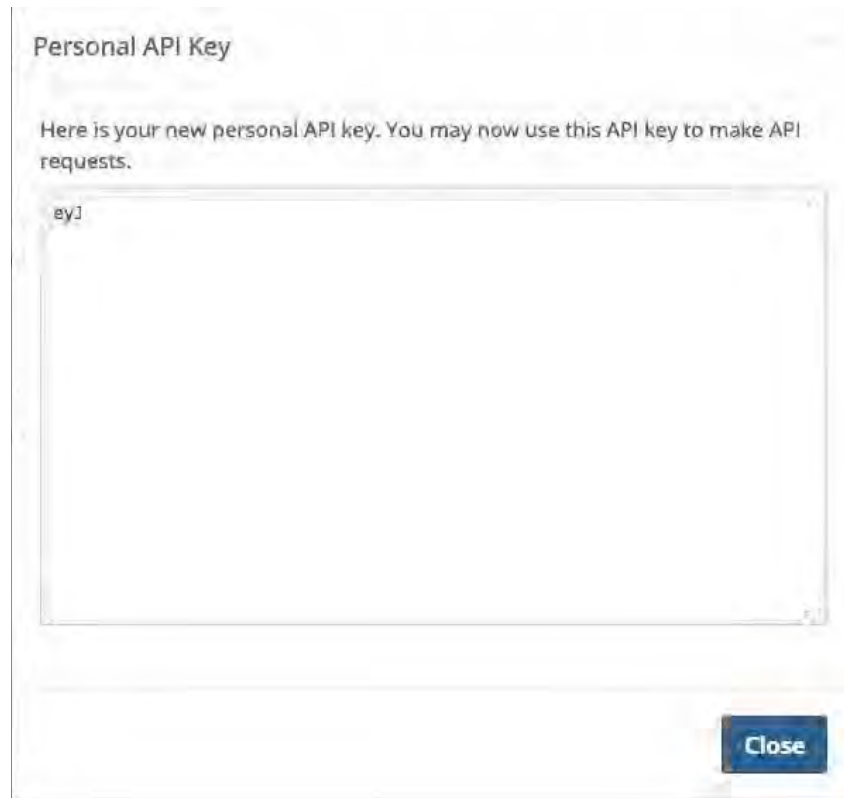


Figure : Step 3 - MultiTech integration

Step 4: Paste the API key on the "Token" field of the "Congigs" tab and press "Save configs".

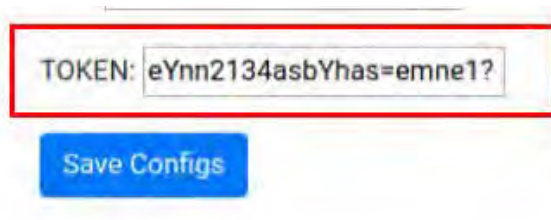


Figure : Step 4: Authorization field on MultiTech integration

Save Service Configuration

Regardless of the service you have configured, click the button "Save configuration" to save your LoRaWAN service configuration. Then a message will be displayed indicating that the service has been updated or saved correctly.

8.1.3. Log

The "Logs" tab shows the information and error messages registering the result of the communication requests of the LoRaWAN services. Different communication protocols are used to configure the service. All messages related to the transport layer of the service are identified as INFO or ERROR. User intervention may be required to analyse the meaning of the messages generated in the application layer and decide if some actions are required.

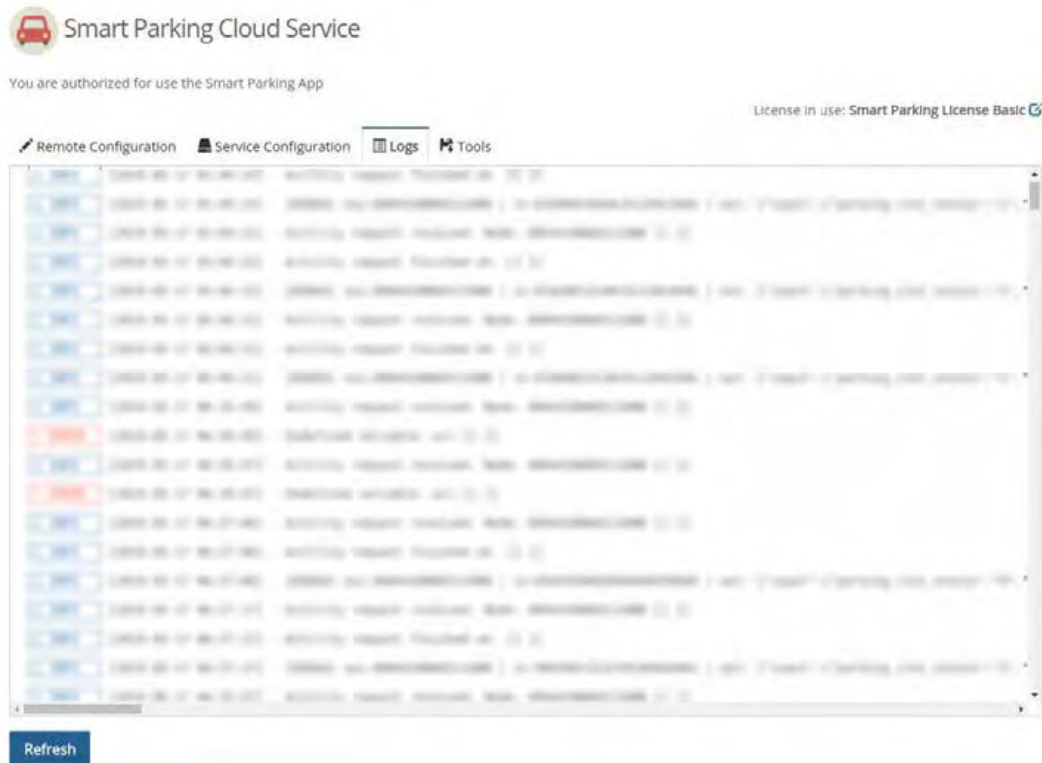


Figure : Log viewer

Click the “Refresh” button to update the log view and load new messages available. The latest messages appear at the bottom of the viewer.



Figure : “Refresh” button

8.1.4. Tools

The “Tools” tab allows users to download the Device Node Keys associated with their account, as well as generate the necessary token to configure your Loriot network server correctly.

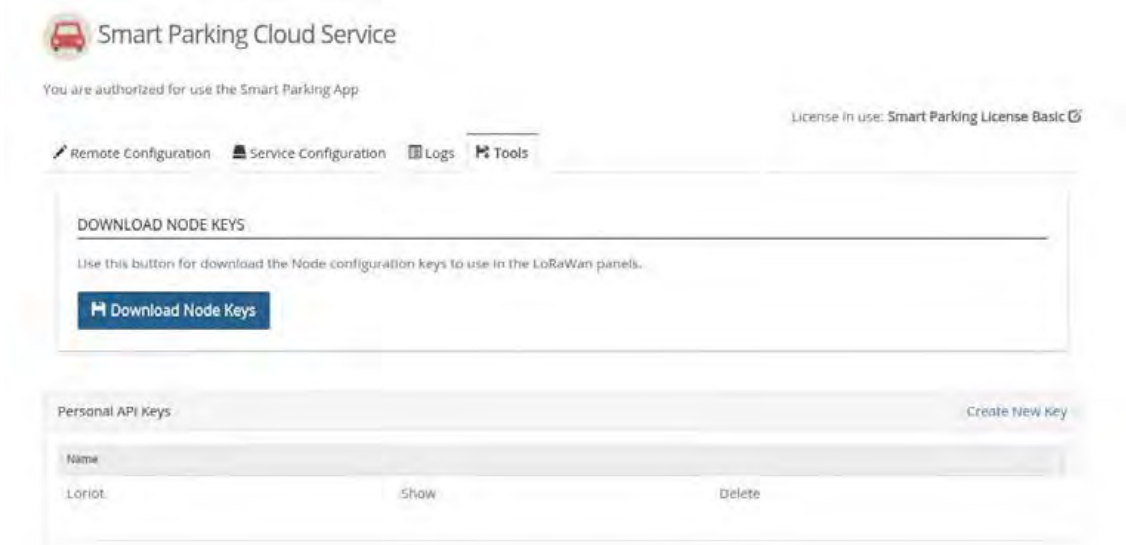


Figure : Tools

The Node Keys is a CSV-format file. It is ready to use in the LoRaWAN Network Server to configure all the Smart Parking nodes associated with their account in the SCM. It can be downloaded by clicking on the “Download Nodes Keys” button.

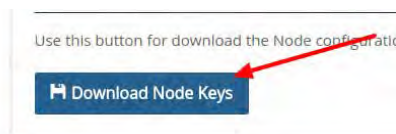


Figure : “Download Nodes Keys” button

Finally, a token must be generated clicking on the “Create New Key” button in order to finish the Loriot service configuration.

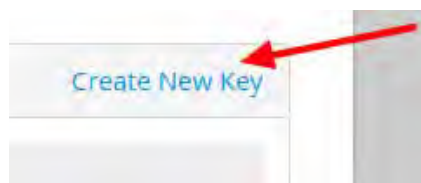


Figure : “Create New Key” button

A pop-up window will be displayed, in which users must introduce a name to identify the new token. Then, clicking the “Create” button shows a password in a new window, ready to be used in the Loriot service.

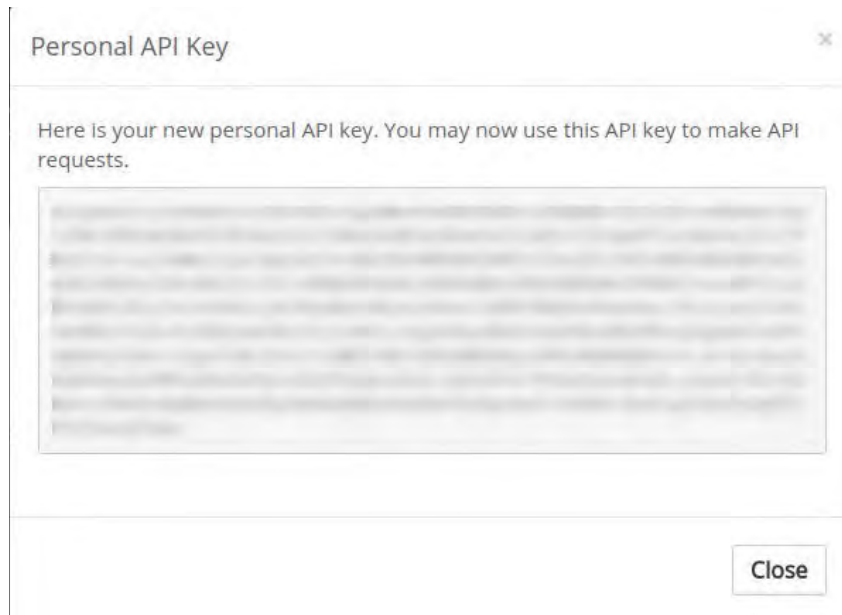


Figure : Generated key

Once the token has been generated, you can use it on Lorient backend as described in the ["Manage Lorient output data"](#) section.

9. Deployment and installation

9.1. 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 to use the default IDs and keys. If factory default keys are used, then a CSV file exported from Libelium Cloud Services Manager (SCM) can be used to ease the bulk import into the LoRaWAN Network Server.
Please refer to the "[Smart Devices App](#)" chapter for further information about the Smart Devices App.
Please refer to the "[Libelium Cloud management](#)" chapter for further information about how to extract the factory default IDs/keys.
2. **Smart Parking Cloud Service or Customer Server setup:** The client must have chosen the type of cloud service to be used: The Smart Parking Cloud Service or her own Customer Server. The Smart Parking Cloud Service is used to receive and forward data to a 3rd party cloud, and the Customer Server is used to receive and store data. So depending on the end-point used, the LoRaWAN Network Server must be configured to properly forward all packets to the desired server.
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.

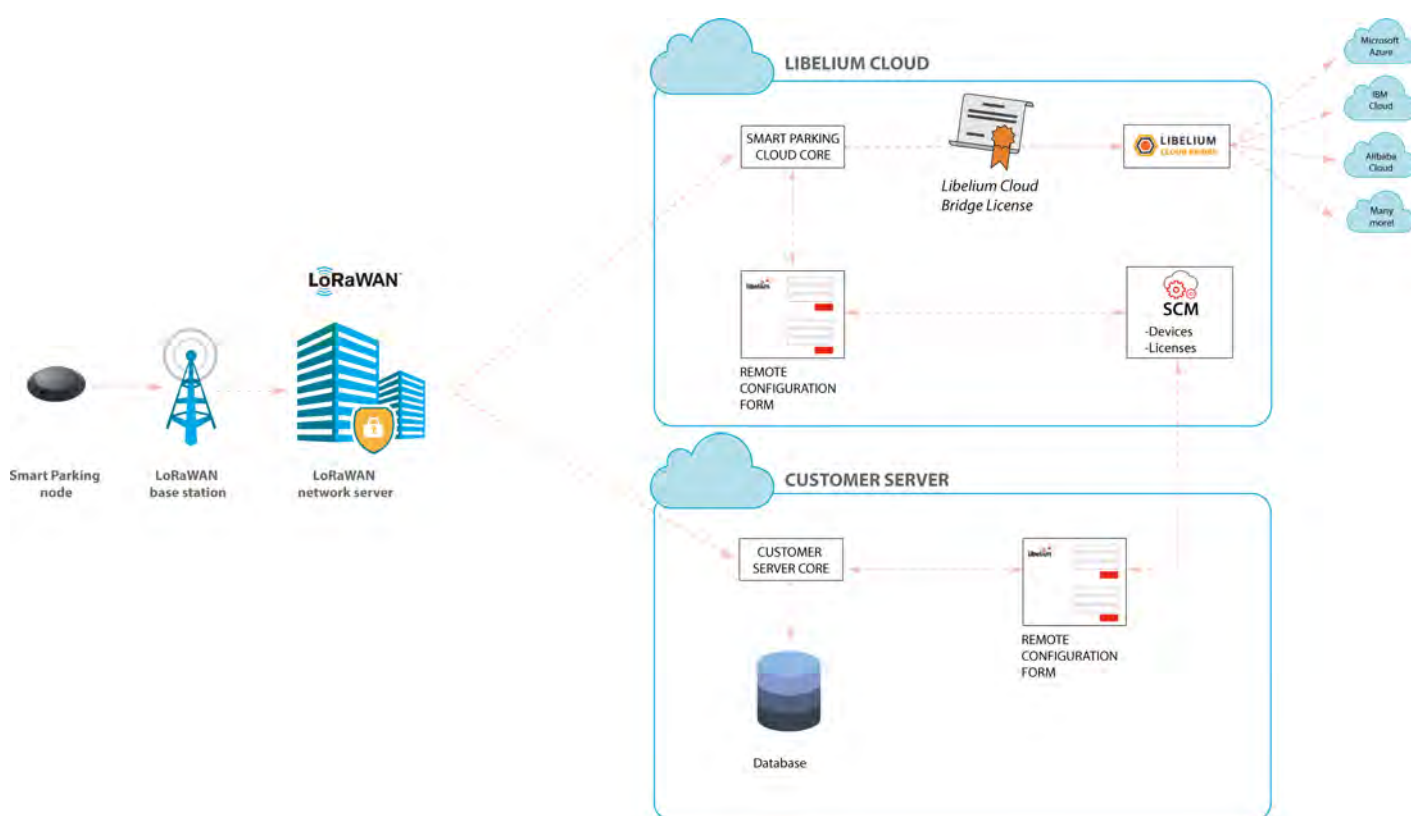


Figure : Smart Parking network architecture

9.2. 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

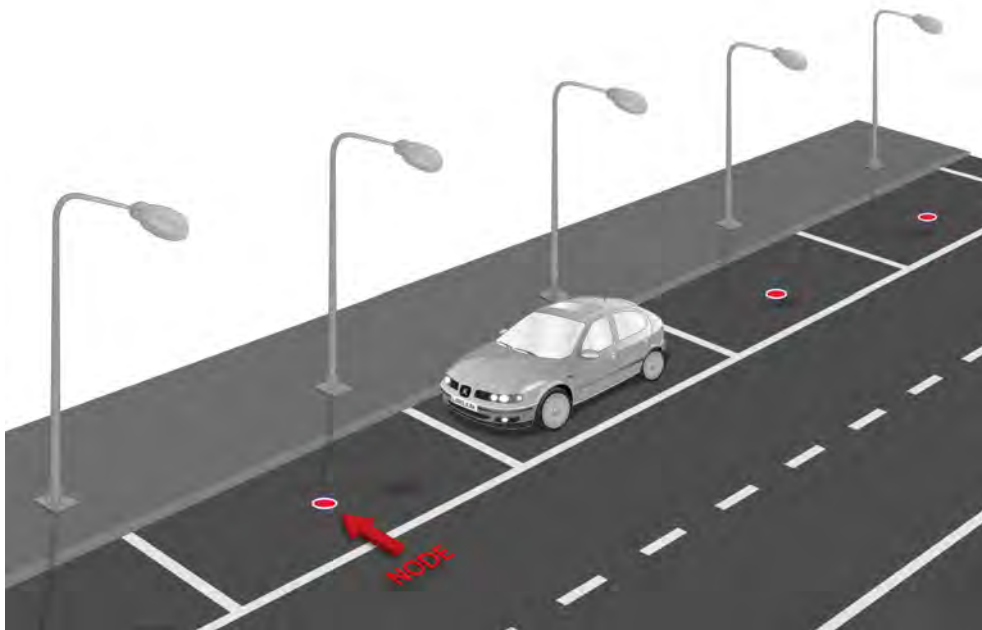


Figure : Parallel parking slots

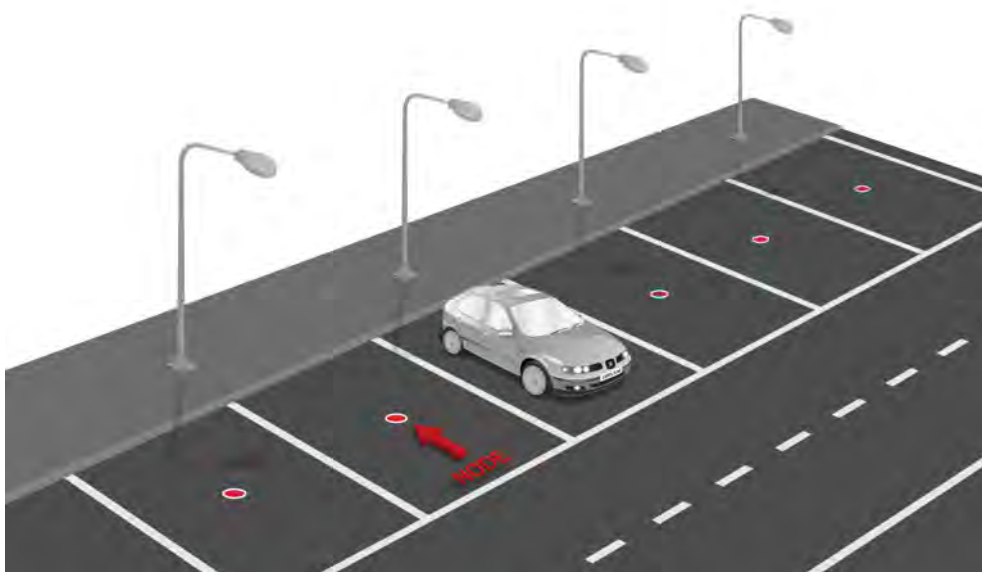


Figure : Perpendicular parking slots

Important:

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.

9.3. Node installation

9.3.1. Triple installation option

The user can choose among the 3 types of installation for the node. This table summarizes pros and cons:

	On-surface installation	Semi-underground installation	Underground installation
Type of enclosure	Vaulted	Vaulted	Flat
Presence of node over the ground	Full node (40.25 mm)	Part of node (6 mm)	Node completely buried (0 cm)
Rain immunity	Yes	Yes	Partial
Puddle immunity	Yes	Yes	Detection may fail if puddle appears
Vandalism/robbery immunity	Medium	High	High
Snowplow immunity	No	Possible	Yes
Installation process	Fast and easy	Special tools needed	Special tools needed
Tools needed	Normal drill	Industrial big crown drill. Epoxy.	Industrial big crown drill. Epoxy.
Can be dismantled for maintenance	Yes	No	No

9.3.2. On-surface node installation

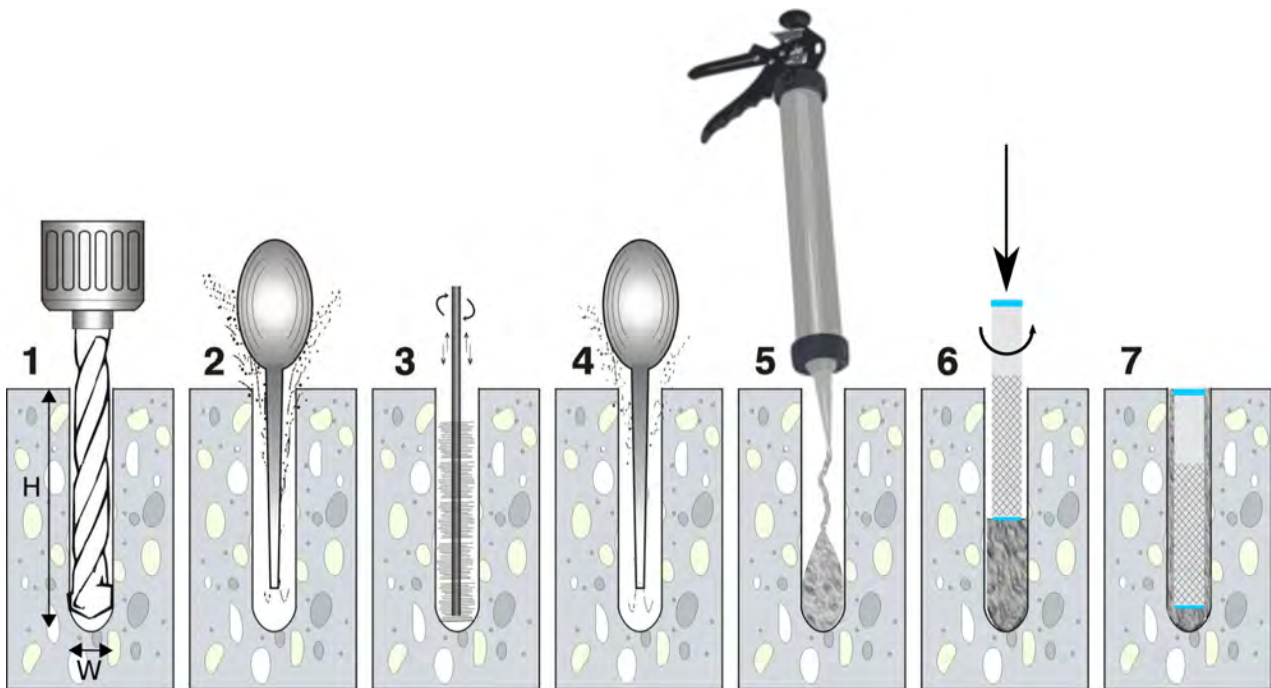


Figure : Step by step chemical fixing and anchor installation

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 : 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.



Figure : Drill the holes (step 1)

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.



Figure : Brush the hole (step 3)



Figure : Blow out dust and loose materials (steps 2 and 4)

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.



Figure : Inject chemical fixing adhesive (step 5)

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 there are no extra adhesive and the anchor installation is clean and smooth.

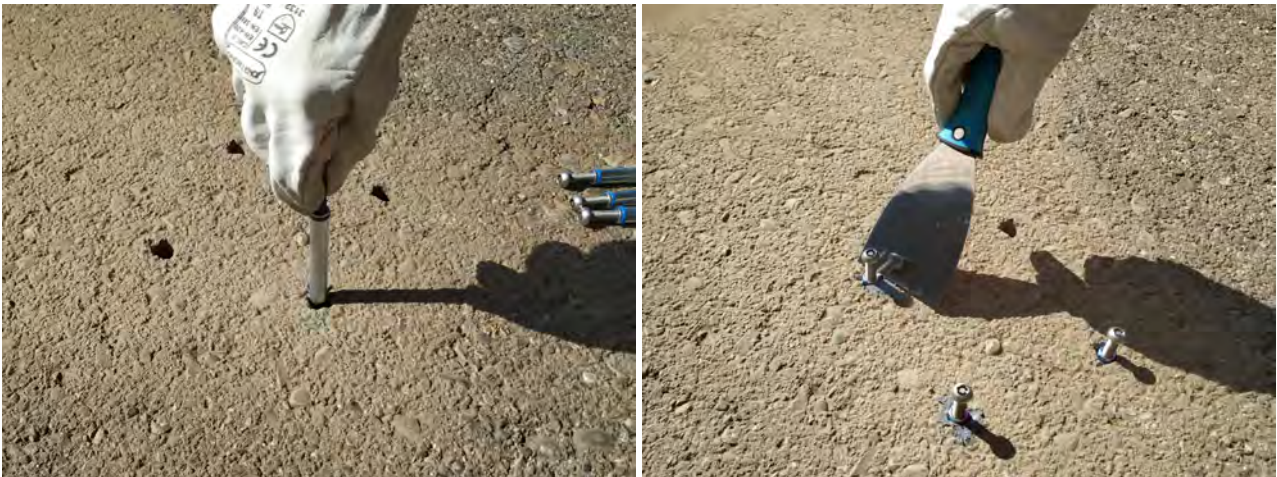


Figure : Insert the anchors (step 6)

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.



Figure : Final anchor installation (step 7)

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.



Figure : Place the circle rubber and the node above it



Figure : Screw the node

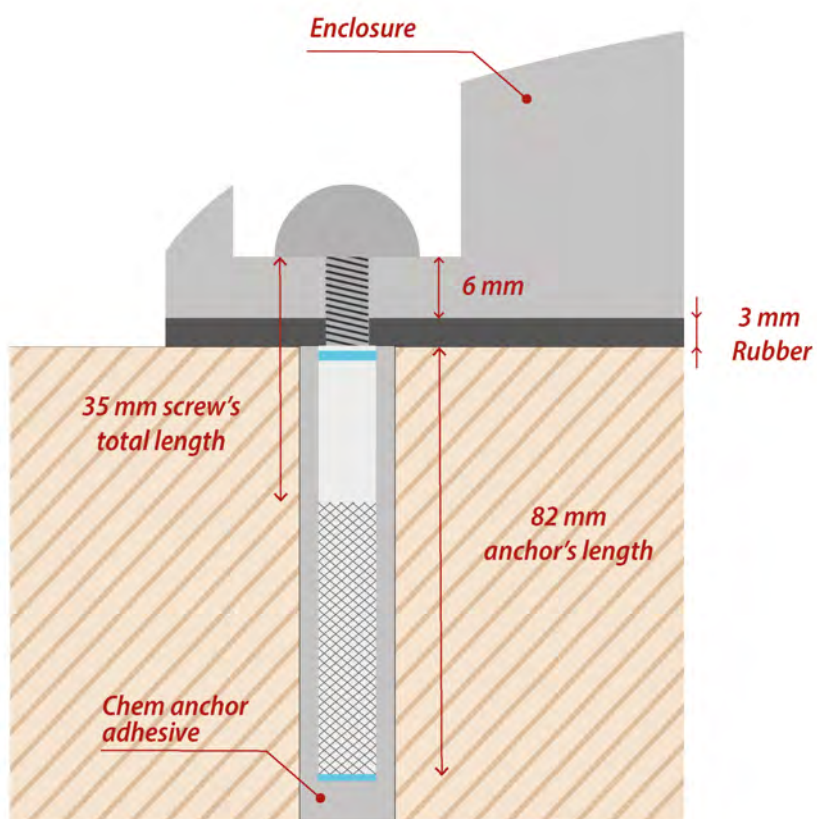


Figure : Final section of the anchor and screw

9.3.3. Underground node installation

Depending on the scenario, placing the node under the pavement can be a must. In cold places where snow is usual, installing the nodes underground permits the use of snowplow equipment without affecting the Smart Parking node. Also, this kind of installation allows the client to deploy much safer networks against vandalism or theft as the device is not accessible directly from the outside.



Figure : Snowplow vehicle

For this special installation, Libelium provides flat enclosures. Contact your Sales agent to order flat enclosures.

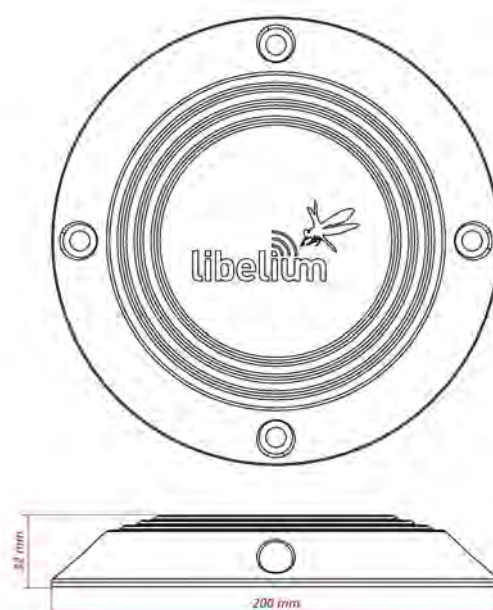


Figure : Flat Smart Parking enclosure dimensions

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

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 : 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.

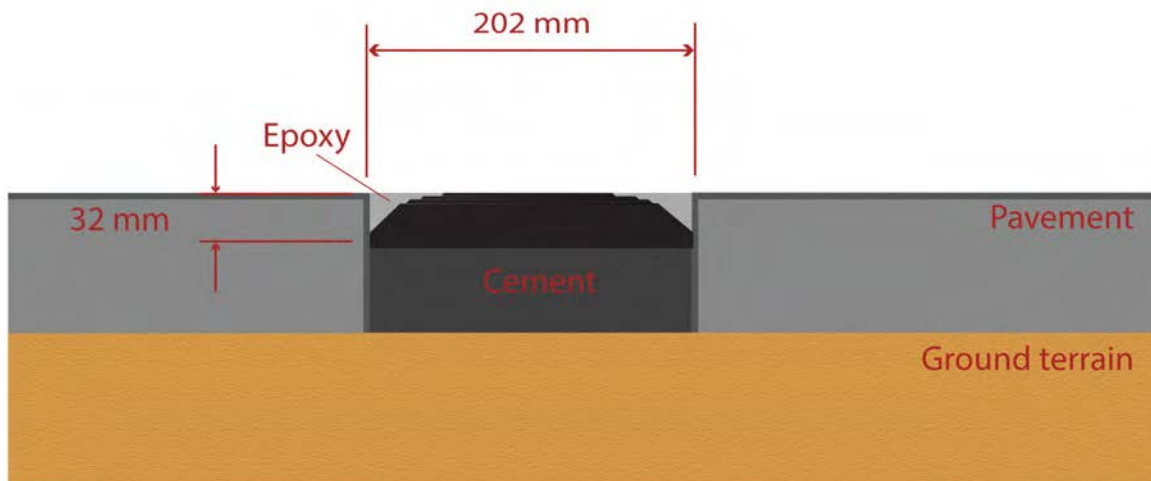


Figure : Placing the node in the hole

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.



Figure : Pour Epoxy curing agent into the granular resinous material



Figure : Preparing the Epoxy resin mixture

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.



Figure : Final Epoxy application

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

9.3.4. Semi-underground node installation

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

The same underground installation steps must be followed as seen in the previous section. 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:

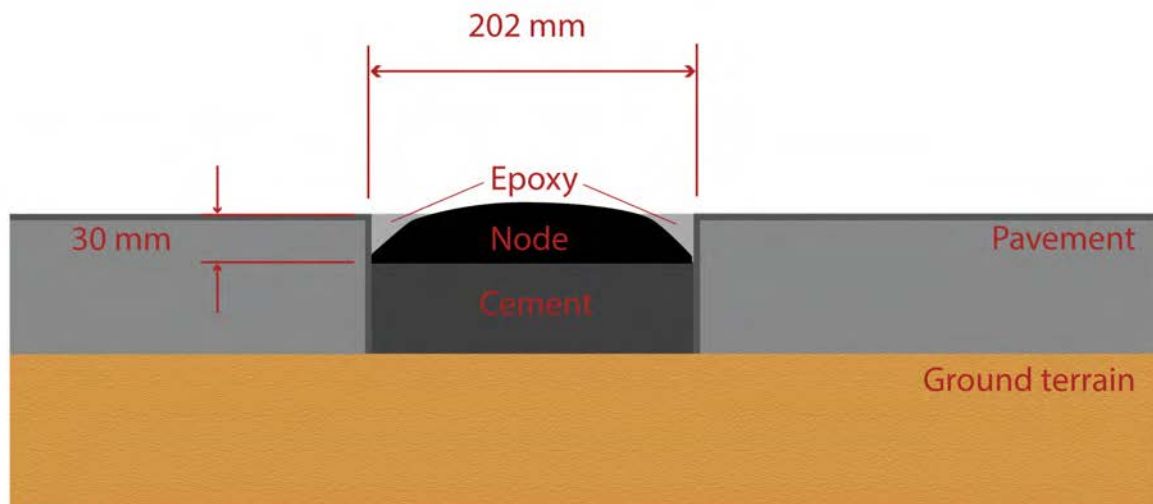


Figure : Semi-underground node installation

9.4. 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 : Using the magnet to start the node

9.5. 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 appreciate the parking lot status during the execution. On the right side you can see the frame types that are sent to the Smart Parking Cloud Service or to the Customer Server depending on: parking slot status changes, elapsed time and user configuration changes.

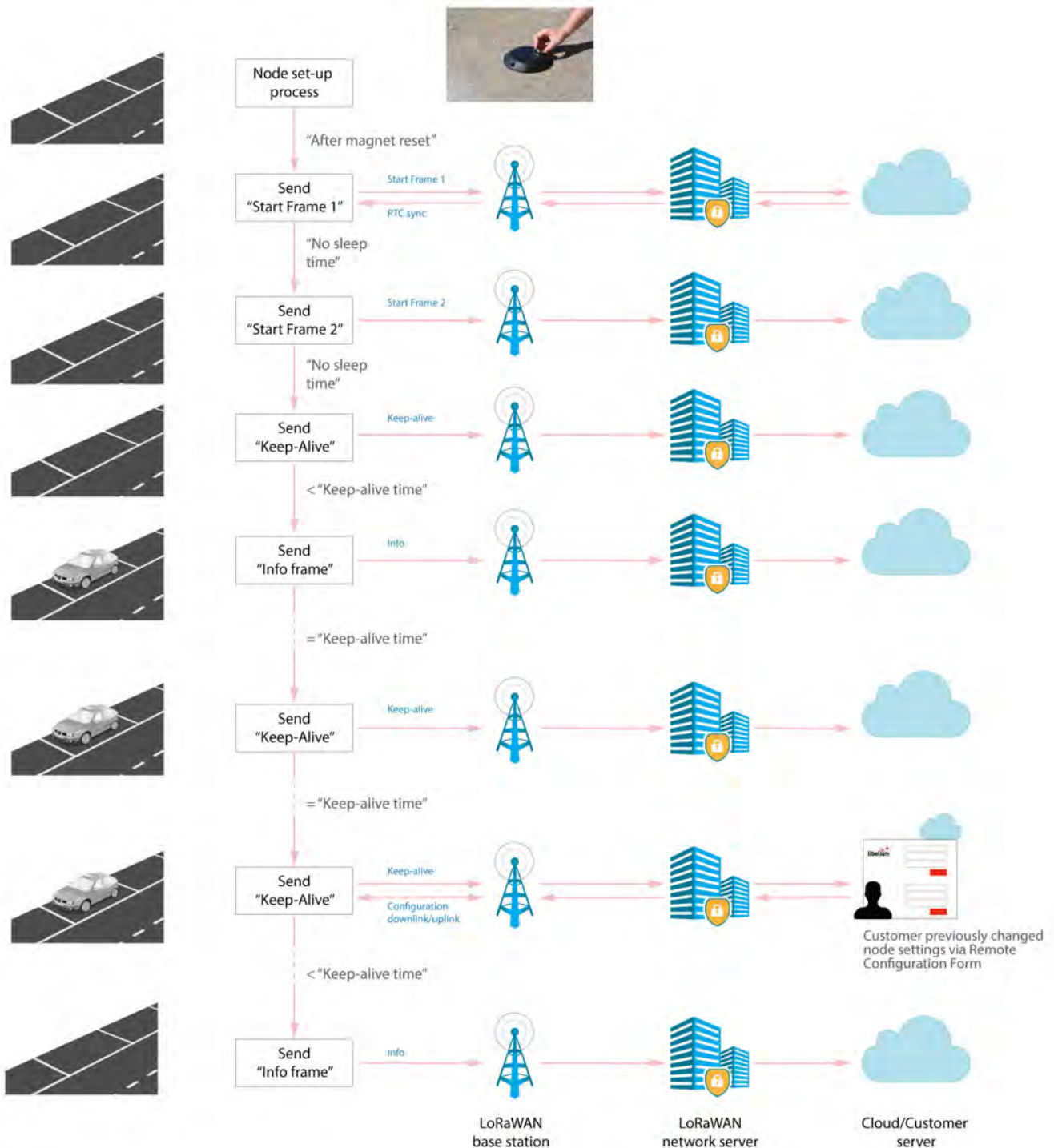


Figure : Smart Parking node working example

10. Certifications

10.1. CE (European Union)

In accordance with the RED Directive, Libelium Comunicaciones Distribuidas S.L. declares that the “Smart Parking v2 EU” device is in conformity with the European Union legislation and with the following harmonized standards and technical specifications:

- EN 50581:2012
- EN 301 489-1 Ver. 2.1.1 (2017-02)
- EN 301 489-3 Ver. 2.1.1 (2017-03)
- EN 305 550-2 V1.2.1 (2014-10)
- Draft EN 305 550 V2.1.0 (2017-10)
- EN 300 220-1 V3.1.1 (2016-11)
- EN 300 220-2 V3.1.1 (2016-11)
- EN 62479:2011
- UNE-EN 62368-1:2014 + AC:2015 + AC1:2015 + AC2:2015 + AC:2017-03 + A11:2017

10.2. 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

If you want to know more, contact the Libelium Sales Department.

11. Safety Guides

11.1. Smart Parking Chemical Fixing Cartridge

Material Safety Data Sheet as per regulation (EC)		fischer innovative solutions
1907/2006		
Commercial Product Name: FIS P 300 T		
Revision date: 30.07.2013	Version: 3.2/en	Print date: 30.07.2013

SECTION 1: Identification of the substance/mixture and of the company/undertaking

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, Hithercroft 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)


SECTION 2: Hazards identification

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



GHS07

Signal word Danger

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. 8; 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 fire-fighting	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/ m3	Remarks	Source
10	inhalable dust	100
4	respirable dust	100

100 - Firmendaten

ethanediol, ethylene glycol

Great Britain

Long-term exposure value/ mg/m3	Remarks	Long-term exposure value/ ppm	Short-term exposure value / ppm	Short-term exposure value / mg/m3	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/ m3	Long-term exposure value/ ppm	Short-term exposure value / mg/ m3	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/ m3	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 - B40/200 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
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
Annex II of MARPOL73/78 and
the IBC Code

not applicable

14.8 Additional information

Other information (chapter 14.) Not dangerous goods in the meaning of ADR/RID, ADN, 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 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 Lorient license type recommendation
- Changed Lorient batch import format due to the new Lorient Network Server 5.0

From v7.0 to v7.1:

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