IoT Soft Box Starter Kit

User Manual for iotsoftbox-mqtt library

Linux Edition

orange™

Table of contents

1. Introduction

1.1. Document purpose

This document is a complete guide to IoT Soft Box SDK for Linux presenting the following:

- Overview
- Getting started
- Detailed Features
- Additional Information

1.2. Reference documents

#	Origin	Title
1	Orange	Datavenue Live Objects - complete guide (1.4.1.)

2. Overview

2.1. What is Live Objects?

Live Objects is one of the products belonging to Orange Datavenue service suite.

Live Objects is a software suite for IoT / M2M solution integrators offering a set of tools to facilitate the interconnection between **devices** or **connected « things »** and **business applications**.

The main features provided are:

- **Connectivity interfaces** (public and private) to collect data, send command or notification from/to IoT/M2M devices,
- **Device management** (supervision, configuration, ressources, firmware, etc.),
- **Message Routing** between devices and business applications,
- **Data Management**: Data Storage with Advanced Search features.

Read Datavenue Live Objects - complete guide to have a full description of services and architecture provided by Live Objects platform.

2.2. Linux

Linux in embedded systems is already being used in consumer electronics like smartTVs or smartphones. In fact the Linux kernel has been ported to many CPU architectures like ARM or AVR32 for the most well-known.

- Linux is a mature and stable alternative to the proprietary OS.
- Linux supports a huge variety of applications and networking protocols.
- Linux is scalable so it can be used in small memory space; also, kernel footprint is less than 500 KB.
- Linux has attracted a huge number of active developers, enabling rapid support of new hardware architectures, platforms, and devices.
- Linux is largely accepted by hardware vendors, chip makers, single board computer maker etc.
- Linux being an open source operating system, it has a huge community supporting various projects to standardize build systems like OpenWrt or Yocto.

Live Objects iotsoftbox-mqtt library is compatible with Linux platform.

2.3. IoT Soft Box

The Live Objects IoT Soft Box is a library to help developers make easy usage of Live Objects platform.

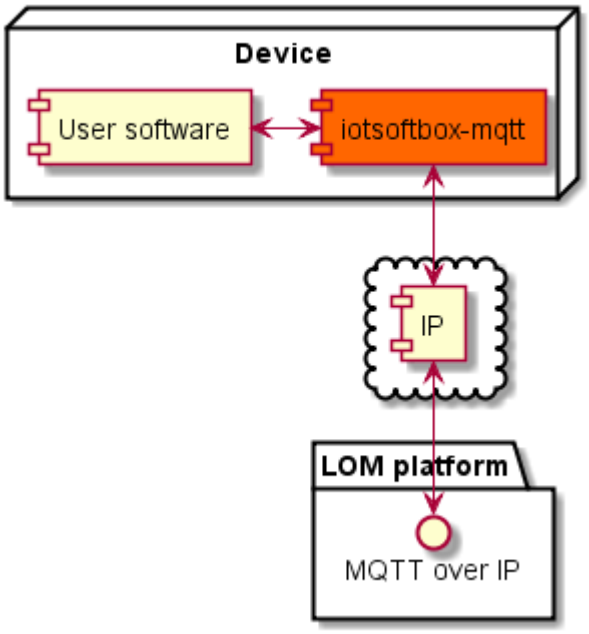


Figure 1 – IoT Soft Box integration in a system

The Live Objects platform is able to manage different formats (MQTT, HTTP …) and several low level protocols (SMS, IP …). The Live Objects IoT Soft Box is designed to work with MQTT over TCP w/o TLS.

The IoT Soft Box can run on devices connected to Internet through Ethernet, Wi-Fi, GPRS or any other IP connection.

The library (iotsoftbox-mqtt) is linked to the following third-party existing libraries:

- Embedded MQTT C/C++ Client Libraries (eclipse paho). This library is available here.
- JSMN, a simple C library only used to parse the received JSON messages. The JSMN is available here.
- Mbed TLS is used to include cryptographic and SSL/TLS capabilities in embedded devices.

3. Getting started

3.1. Hardware Environment

To test our SDK, use a compatible hardware, like:

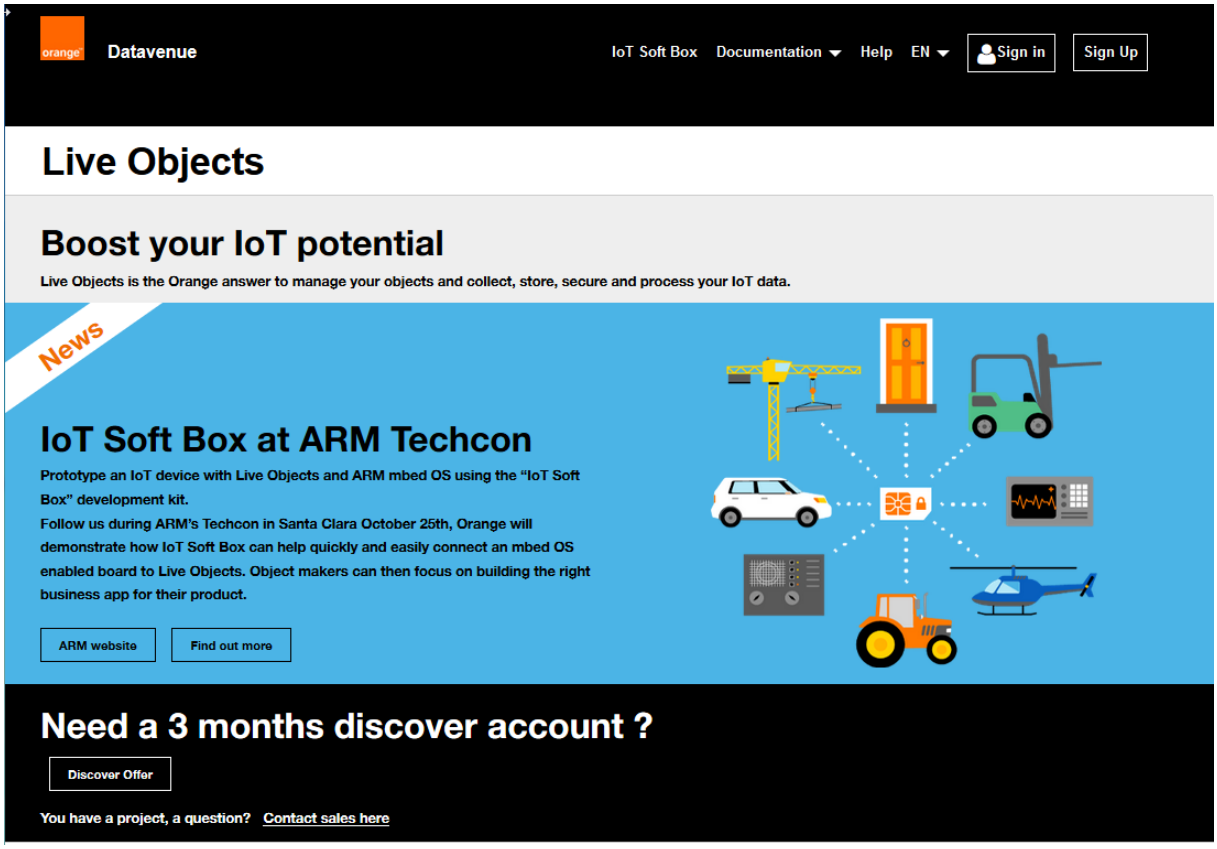
- A Raspberry Pi model B with Raspbian Jessie as Linux distribution
- A Raspberry Pi 3 model B, with Raspbian Jessie as Linux distribution

3.2. Access to Live Objects

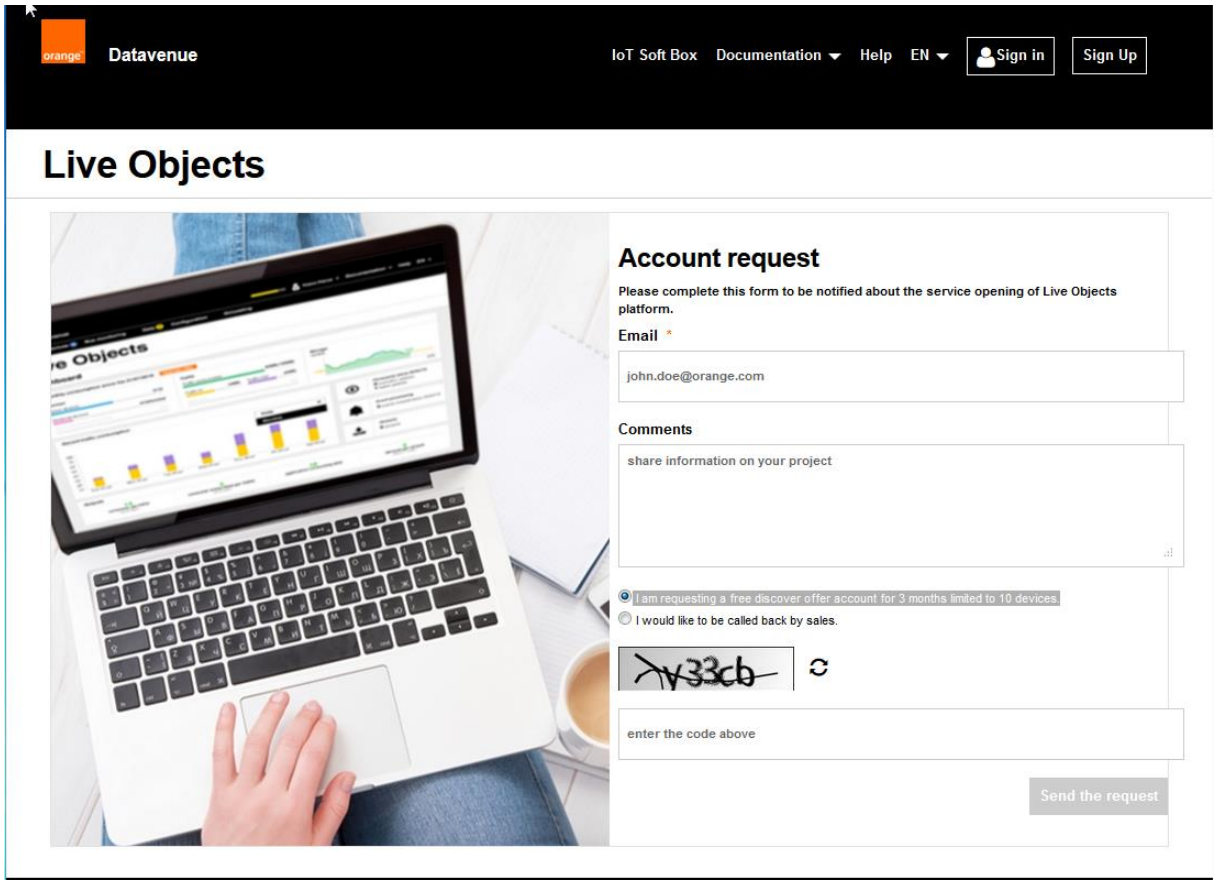
3.2.1. Account creation

In order to use Live Objects, you need to have a dedicated account on the service.

1. Go to Live Objects portal (https://liveobjects.orange-business.com/).



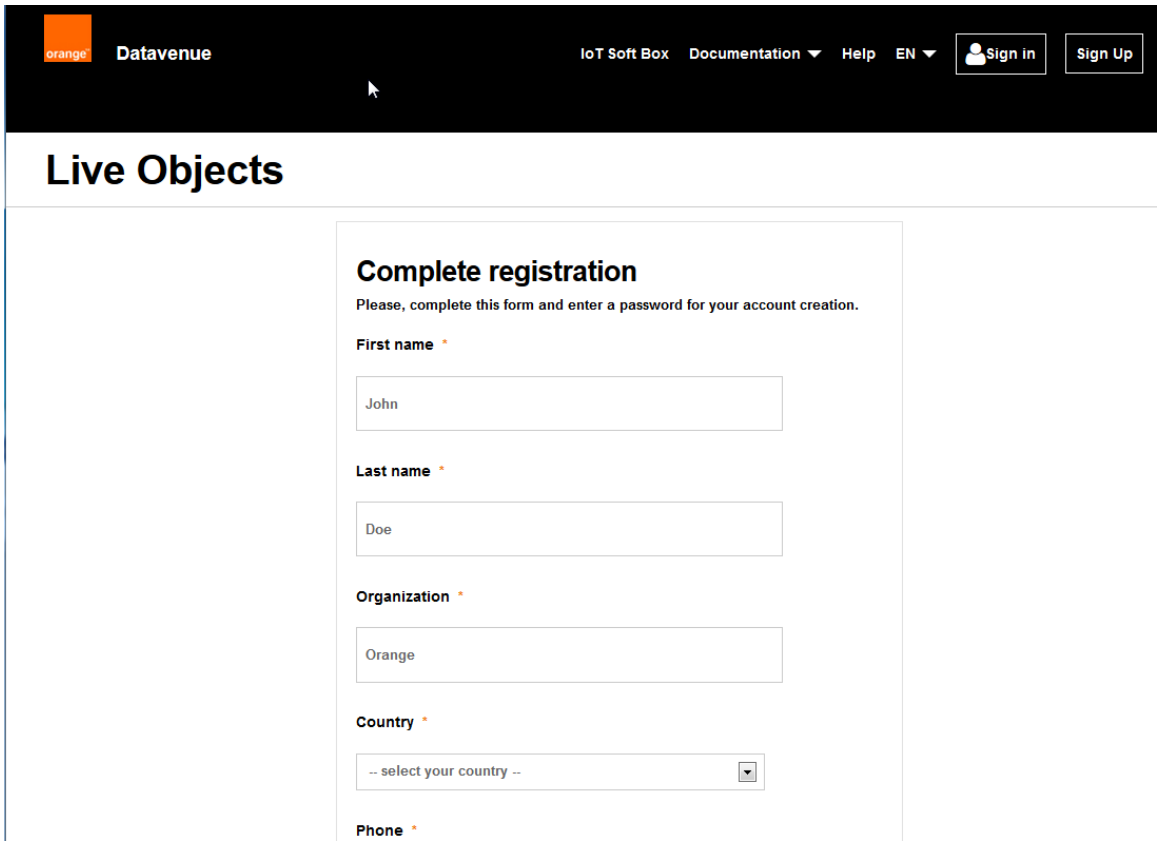
2. Click on '**Discover Offer**' button (or Sign Up) and fill the form, checking option 'I am requesting a free discover offer account for 3 months limited to 10 devices'.



3. Then you will receive an e-mail to activate your Live Objects account.

> Hello,
>
> You just subscribed to Live Objects portal.
>
> Please, use this link to activate your account 'john' and define your password.
>
> 'john' Account activation
>
> Thank you for your trust.
>
> Orange Business Service Customer Support.
>
> This is an automatically generated email, please do not reply.

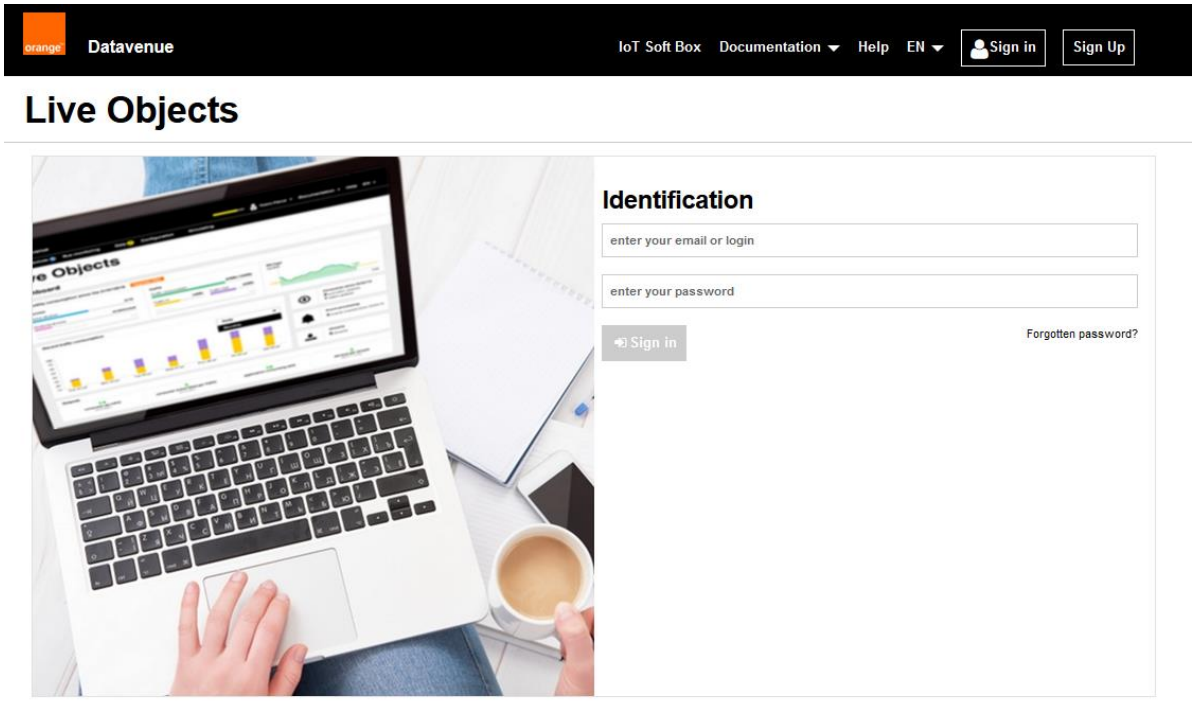
4. Follow the link, fill the form, and click on ‘Validate’.



5. Now, you can go back to Datavenue Live Objects portal and sign in. Once logged, select the ‘configuration’ tab to create a new API key.

3.2.2. Log in

To log in to Live Objects web portal, connect to liveobjects.orange-business.com using your web-browser:

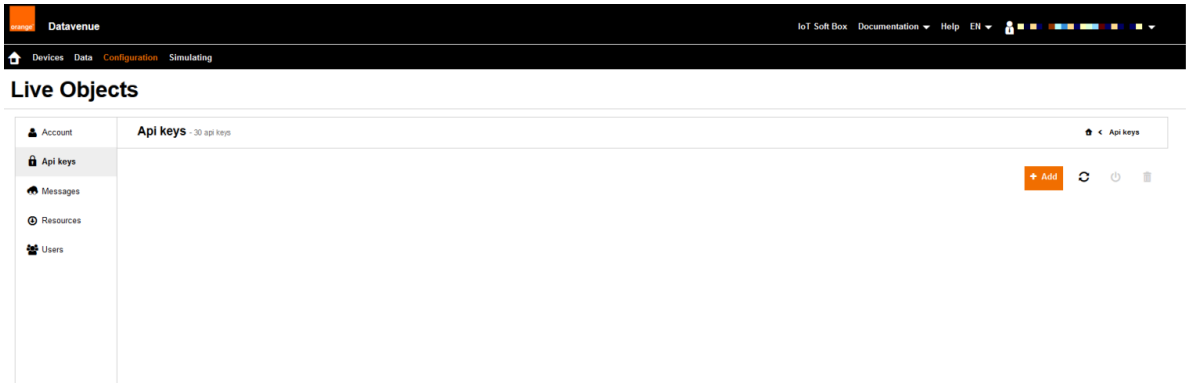


1. Fill the “Log in” form with your credentials:
    - your email address,
    - the password set during the activation phase,
2. Then click on the “Log in” button.

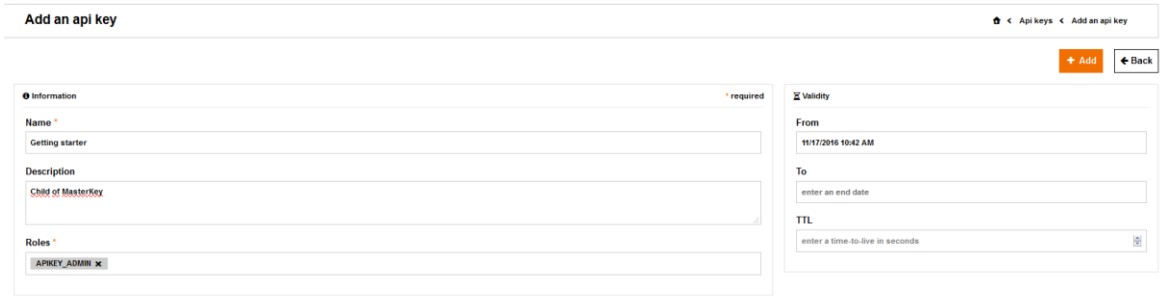
If the credentials are correct, a success message is displayed and you are redirected to your “home” page:

3.2.3. API Key creation

To get a device or an application communicating with Live Objects, you will need to create an API Key in the “Configuration” menu. On the left menu, click on "API keys" and create a new API key. This key will be necessary to set up a connection with the public interfaces (MQTT and REST) of Live Objects.



As a security measure, you cannot retrieve the API Key again after closing the API key creation results page. So, note it down to work with the MQTT client, during the scope of this getting started.



3.3. Live Objects IoT examples using iotsoftbox-mqtt library

3.3.1. Introduction

A good way to discover Live Objects features is to use our Live Objects IoT examples.

When running on a development board, the embedded 'basic' application:

1. Connects to Datavenue Live Objects Platform, using:
   - an optional secure connection (TLS)
   - the LiveObjects mode: Json+Device
2. Publishs
   - The current Status/Info
   - The current Configuration Parameters
   - The current Resources
3. Subscribes to Live Objects topics to receive notifications
   - Configuration Parameters update request
   - Resource update request
   - Command request
4. then the application waits for an event:
   - From Live Objects platform to:
     - Update "Configuration Parameters"
     - Update one "Resource": message or image
     - Process a "Command": RESET or LED
   - From application simulating some data publish operations.
   - And if the connection is lost, restart at step 2

3.3.2. Packages dependences

The example applications have been built and tested with the following packages:

1) *Mbed-TLS*

https://github.com/ARMmbed/mbedtls
Latest commit : cb587009d679812dc27979c867cdc0e056a132e6

2) *Paho MQTT embedded-c*

https://github.com/eclipse/paho.mqtt.embedded-c
Latest commit : f834fae3d0bb4515c536851536cbe6b5f6f3d1ef

3) *jsmn*

https://github.com/zserge/jsmn
Latest commit : 1682c32e9ae5990ddd0f0e907270a0f6dde5cbe9

4) *iotsoftbox-mqtt-core (the latest release of library on github)*

https://github.com/Orange-OpenSource/LiveObjects-iotSoftbox-mqtt-core
Latest Commit : b18c7e1e0d7d2281848e22acbe45aa45c7d8d9af

3.3.3. Configure workstation for cross compilation

3.3.3.1. Linux

This example is given for a Linux Debian as a host machine and a Raspberry pi 3 as a target. Instructions for a Raspberry pi 1 are also given.

1. Install the cross compiler

```
echo "deb http://emdebian.org/tools/debian/ jessie main" >
/etc/apt/sources.list.d/crosstools.list
curl http://emdebian.org/tools/debian/emdebian-toolchain-archive.key | sudo
apt-key add -
# Raspberry Pi 1
# sudo dpkg --add-architecture armel
sudo dpkg --add-architecture armhf
sudo apt-get update
# Raspberry Pi 1
# sudo apt-get install git git-flow cmake crossbuild-essential-armel
sudo apt-get install crossbuild-essential-armhf
```

3.3.3.2. Windows

This example is given for a Windows 7 as a host machine and a Raspberry pi as a target

1. Install the compiler.
2. Update the cross compiler environment, by downloading the Sysroot. To do so, use C:\SysGCC\Raspberry\TOOLS\UpdateSysroot.bat
3. Install CMake.
4. Install Perl to run CMake properly.

You MUST redo step 2 each time you add a library to the target platform.

3.3.4. Build

3.3.4.1. Submodule update

You will need to download the third-party libraries. Two options for that:

1. Using --recursive when cloning the main library.

```
git clone --recursive https://github.com/foo/bar.git
```

2. Using git submodule in the repository

```
git clone https://github.com/foo/bar.git
cd bar
```

```
git submodule init
git submodule update
```

3.3.4.2. Linux

1. Local build

```
mkdir build
cd build
cmake ..
make
```

2. Cross-Compilation build

```
mkdir build
cd build
cmake -DCMAKE_C_COMPILER=<Path to the compiler> ..
make
```

For the raspberry pi 3, the compiler will be “arm-linux-gnueabihf-gcc” and for the PI 1 “arm-linux-gnueabi-gcc”

3.3.4.3. Windows

You can only cross compile the program on Windows, using the following:

```
mkdir build
cd build
copy ..\lib\iotsoftbox-mqtt-linux\cmakeWinSetup.bat .
cmakeWinSetup.bat
make
```

3.3.5. Launch

3.3.5.1. Load the sample on your Raspberry Pi

1) Make sure your Raspberry Pi is connected to the internet
2) Use a Secure CoPy (scp) tool to copy the executable (if you’re using Windows) on the board.

3.3.5.2. Execute

Run the executable:

```
./<you’re binary name>
```

in the correct directory.

3.3.5.3. Application Monitoring/Testing

There is several ways to monitor or/and to test the embedded sample application:

- Go to your Live Objects user account on Live Objects Portal.
- Go to Live Objects Swagger User Interface.
- Serial Terminal is used by embedded sample application to print debug/trace messages.

From Live Objects you can see your board, check the status, send commands, update resources and more.

4. Detailed Features

4.1. General

The Live Objects IoT Soft Box is a library providing features to connect embedded device to the Datavenue Live Objects platform.

> Today, a library dedicated to Linux boards is available here, library called **LiveObjects-iotSoftbox-mqtt-linux.**

The **LiveObjects-iotSoftbox-mqtt** library provides APIs to help developers create their embedded IoT applications. The API is written in C.

The **LiveObjects-iotSoftbox-mqtt** library uses Live Objects 'Device' mode: a single MQTT connection is associated with the device, and JSON messages can be exchanged to support various *Device Management* and *Data* features. See "Device" mode paragraph in Live Objects User Manual to have a full description.

IoT Soft Box available features are:

- Connection to the user tenant of Live Objects platform w/wo security (TLS)
- Device Management
- Status
- Configuration Parameters
- Collected data
- Commands
- Resources

4.2. Connectivity

The endpoint (Live Objects server) is defined at compile time.

The default values are defined in the iotsoftbox-mqtt library as:

- IP Address: 84.39.42.214
- TCP Port:
  - 1883 for non SSL connection (without security),
  - 8883 for TLS/SSL connection.
- If TLS is enabled.
  - Public Root Certificate
  - Certificate Common Name 'm2m.orange.com'

Therefore the user has only to define in the user header file **liveobjects_dev_params.h**:

- Tenant *ApiKey* parameter
- if the TLS is enabled (value : 1) or not (value : 0)

```
/* Set to 1 to enable TLS feature*/
/* (warning: check that LOC_SERV_PORT is the correct port in this case)*/
#define SECURITY_ENABLED                    1

/* Here, set your LiveObject Apikey. It is mandatory to run the application*/
#define LOC_CLIENT_DEV_API_KEY              "Your API key here"
```

When TLS is enabled, security parameters must be defined/updated in the following header file **liveobjects_dev_security.h**.

However if necessary, the endpoint parameters can be overwritten by parameters defined in this user header file: **liveobjects_dev_params.h**.

```
/* Only used to overwrite the LiveOjects Server settings :*/
/* IP address, TCP port, Connection timeout in milliseconds.*/
#define LOC_SERV_IP_ADDRESS                 "XXXX"
#define LOC_SERV_PORT                       XXXX
#define LOC_SERV_TIMEOUT                    XXXX
```

4.3. Device

Within Datavenue Live Objects platform, the device is identified by its URN:

`urn:lo:nsid:{`***namespace***`}:{`***id***`}`

The device has to specify:

- *Namespace* identifier, used to avoid conflicts between various families of identifier (ex: device model, identifier class "imei", msisdn", "mac", etc.).
  Should preferably only contain alphanumeric characters (a-z, A-Z, 0-9).
- *Id* (ex: IMEI, serial number, MAC address, etc.)
  Should only contain alphanumeric characters (a-z, A-Z, 0-9) and/or any special characters amongst: - _ | + and must avoid # / !.

These two parameters are specified in the user header file **liveobjects_dev_params.h:**

```
/* When set to 1, use the MAC address as LiveObject device identifier*/
/* otherwise use LOC_CLIENT_DEV_ID*/
#define LOC_CLIENT_USE_MAC_ADDR             0

/* Default LiveObjects device settings : name space and device identifier*/
#define LOC_CLIENT_DEV_NAME_SPACE           "LiveObjectsDomain"
#if !LOC_CLIENT_USE_MAC_ADDR
#define LOC_CLIENT_DEV_ID                   "LO_softboxlinux_01"
#endif
```

If `LOC_CLIENT_USE_MAC_ADDR` is set to 1, the iotsoftbox-mqtt library uses the physical network address (Ethernet MAC address, ..) for the device identifier, otherwise the device identifier is defined by `LOC_CLIENT_DEV_ID`

4.4. Thread Models: Multi-thread or single thread.

The library offers both thread models to build the user embedded application:

1. Single thread. The user application has to schedule all tasks (or to call functions) in one same thread.
2. Multi-thread: A function of iotsoftbox-mqtt library allows the creation/activation of specific thread:
    - To maintain the TCP connection (w/wo TLS) to the Live Objects platform
    - To process all events from/to the Live Objects platform.

Note that our sample running with Linux uses the multi-thread model.

4.5. Status

Status gives information about the device states, i.e. Software version, IP address, connection state, statistic counters.

4.5.1. Attach a set of 'status' data

At any moment, the application can attach one or many set (or group) of 'status' data by calling the function:

```
int LiveObjectsClient_AttachStatus(const LiveObjectsD_Data_t* status_ptr,
                int32_t status_nb);
```

In the sample application:

```
appv_hdl_status = LiveObjectsClient_AttachStatus(appv_set_status, SET_STATUS_NB);
```

The set of 'status' data is defined by an array of `LiveObjectsD_Data_t` elements. For example:

```
#define APPV_VERSION "LINUX BASIC SAMPLE V01.01"
int32_t appv_status_counter = 0;
char appv_status_message[150] = "READY";

/// Set of status
LiveObjectsD_Data_t appv_set_status[] = {
                { LOD_TYPE_STRING_C, "sample_version", APPV_VERSION },
                { LOD_TYPE_INT32, "sample_counter", &appv_status_counter },
                { LOD_TYPE_STRING_C, "sample_message", appv_status_message }
};
```

4.5.2. Push a set of ‘status’ data

When ‘status’ data change, the application must call the `LiveObjectsClient_PushStatus( )` function to notify the Datavenue Live Objects platform (publishing a MQTT message on the dev/info topic):

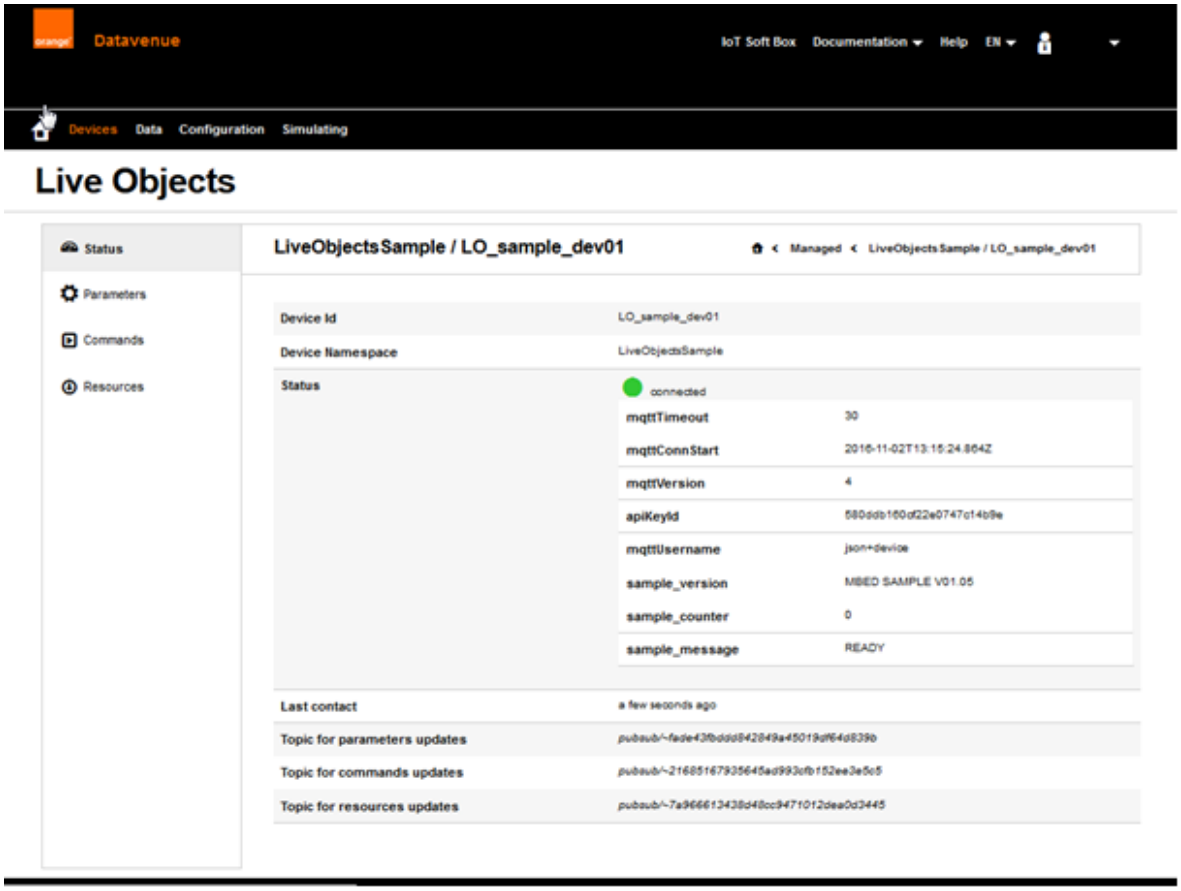
```
ret = LiveObjectsClient_PushStatus(appv_hdl_status);
```

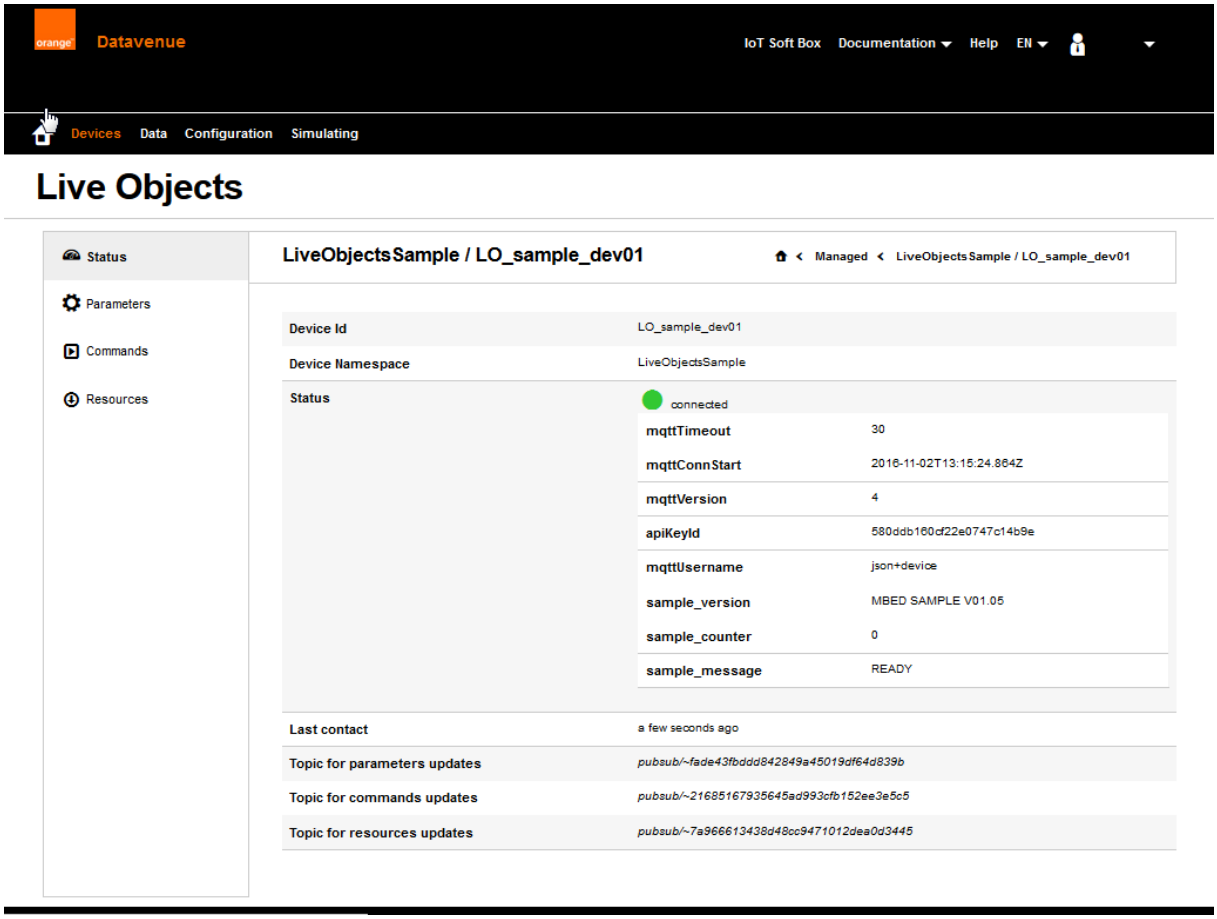
Note:

- if the status data is attached before connecting to the platform, the ‘status’ data will be automatically pushed as soon as the MQTT connection is established with the Live Objects platform.

4.5.3. Use of Live Objects portal to view/check the set of status

On the Datavenue Live Objects portal, the user can check the ‘status’ of its connected device:

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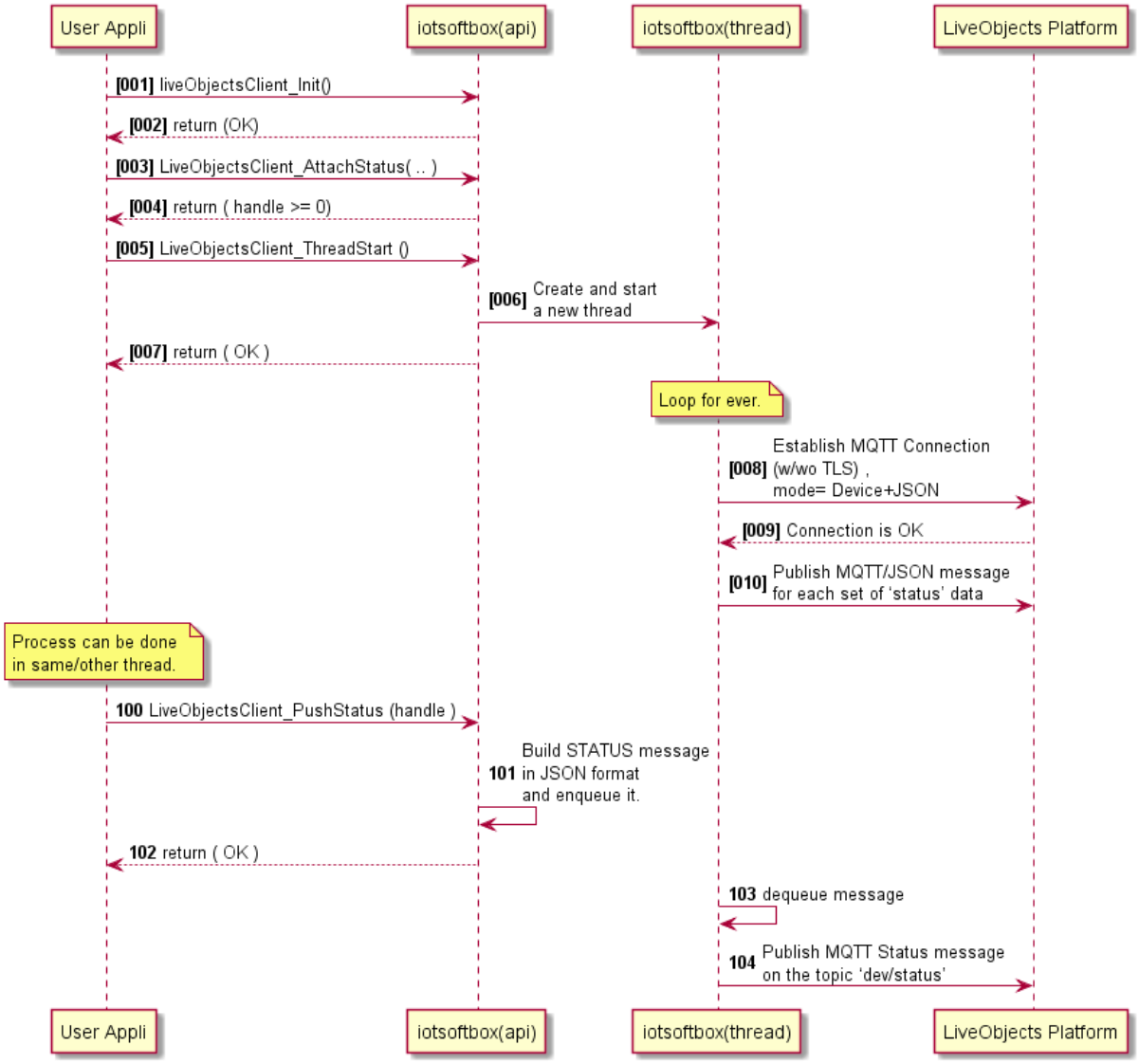
Status
Parameters
Commands
Resources
LiveObjectsSample / LO_sample_dev01
Managed < LiveObjectsSample / LO_sample_dev01
Device Id
LO_sample_dev01
Device Namespace
LiveObjectsSample
Status
connected
mqttTimeout
30
mqttConnStart
2016-11-02T13:15:24.864Z
mqttVersion
4
apiKeyId
580ddb160cf22e0747c14b9e
mqttUsername
json+device
sample_version
MBED SAMPLE V01.05
sample_counter
0
sample_message
READY
Last contact
a few seconds ago
Topic for parameters updates
pubsub/~fade43fbddd842849a45019df64d839b
Topic for commands updates
pubsub/~21685167935645ad993cfb152ee3e5c5
Topic for resources updates
pubsub/~7a966613438d48cc9471012dea0d3445

4.5.4. Sequence Diagram



4.6. Parameters

The device can declare one or many Live Objects "*parameters*" of device configurations.

Then, Live Objects can track the changes of the current value of device parameters, and allow users to set different target values for those parameters. Live Objects will then update the parameters on the device once it's connected and available.

4.6.1. Attach a set of configuration parameters

Application can declare/attach only one set of configuration parameters to the iotsoftbox-mqtt library by calling the function:

```
int LiveObjectsClient_AttachCfgParams(
                const LiveObjectsD_Param_t *param_ptr,
                int32_t param_nb,
                LiveObjectsD_CallbackParams_t callback);
```

In the sample application:

```
ret = LiveObjectsClient_AttachCfgParams(appv_set_param, SET_PARAM_NB,
       main_cb_param_udp);
```

Where:

1. The set of 'parameters' data is defined by an array of `LiveObjectsD_Param_t` elements. In the sample application:

```
// definition of identifer for each kind of parameters
#define PARM_IDX_NAME 1
#define PARM_IDX_TIMEOUT 2
#define PARM_IDX_THRESHOLD 3
#define PARM_IDX_GAIN 4

/// Set of configuration parameters
LiveObjectsD_Param_t appv_set_param[] = {
       { PARM_IDX_NAME, { LOD_TYPE_STRING_C, "name", appv_conf.name } },
       { PARM_IDX_TIMEOUT, { LOD_TYPE_UINT32, "timeout", (void*) &appv_cfg_timeout } },
       { PARM_IDX_THRESHOLD, { LOD_TYPE_INT32,    "threshold", &appv_conf.threshold } },
       { PARM_IDX_GAIN, { LOD_TYPE_FLOAT, "gain", &appv_conf.gain } }
};
#define SET_PARAM_NB (sizeof(appv_set_param) / sizeof(LiveObjectsD_Param_t))
```

   And the configuration parameters are defined and initialized as:

```
// a structure containing various kind of parameters (char[], int and float)
struct conf_s {
       char name[20];
       int32_t threshold;
       float gain;
} appv_conf = { "TICTAC", -3, 1.05 };
```

2. The application specifies the callback function (i.e. `paramUdpdateCb`) which will be called when a request is received from the Live Objects platform to change the value of parameter.

```
int main_cb_param_udp(const LiveObjectsD_Param_t *param_ptr, const void *value,
        int len) {
        if (param_ptr == NULL) {
                return -1;
        }
        switch (param_ptr->parm_uref) {
        case PARM_IDX_NAME: {
                …
                if (paramIsOk) {
                        return 0;
                }
                break;
        }
        case PARM_IDX_TIMEOUT: {
                …
                if (paramIsOk) {
                        return 0;
                }
                break;
        case PARM_IDX_THRESHOLD: {
                …
                if (paramIsOk) {
                        return 0;
                }
                break;
        case PARM_IDX_GAIN: {
                …
                if (paramIsOk) {
                        return 0;
                }
                break;
        }
        return -1;
}
```

With the Switch statement you can adapt the behavior of your app for each param.

Notes:

- When the user callback returns 0 to accept the new value for a ‘primitive’ parameter (integer, float ...), the iotsoftbox-mqtt library updates the value of this configuration parameter. But for the ‘c-string’ parameter, the user application has to copy the value in the good memory place (with the good size).
- The ‘parameters’ data will be automatically pushed as soon as the MQTT connection is established with the LiveObjects platform.

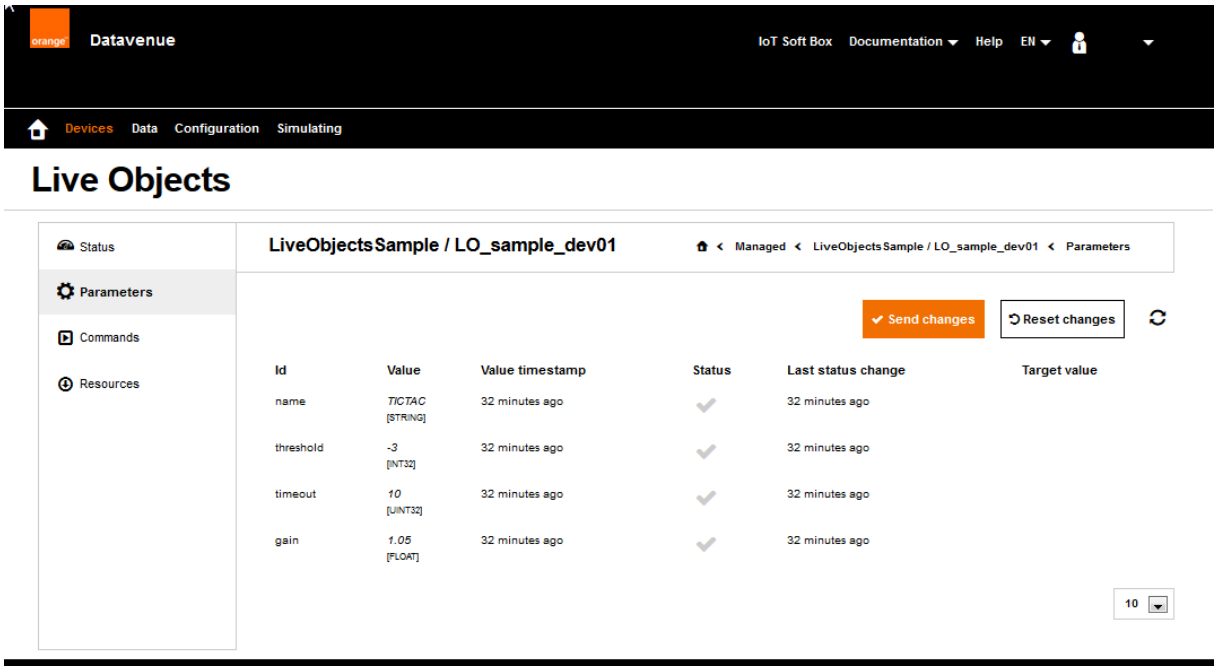
4.6.2. Push a set of configuration parameters

The application can call the `LiveObjectsClient_PushCfgParams( )` function to notify the Datavenue Live Objects platform (publishing a MQTT message on the dev/cfg topic) that the current configuration is updated:

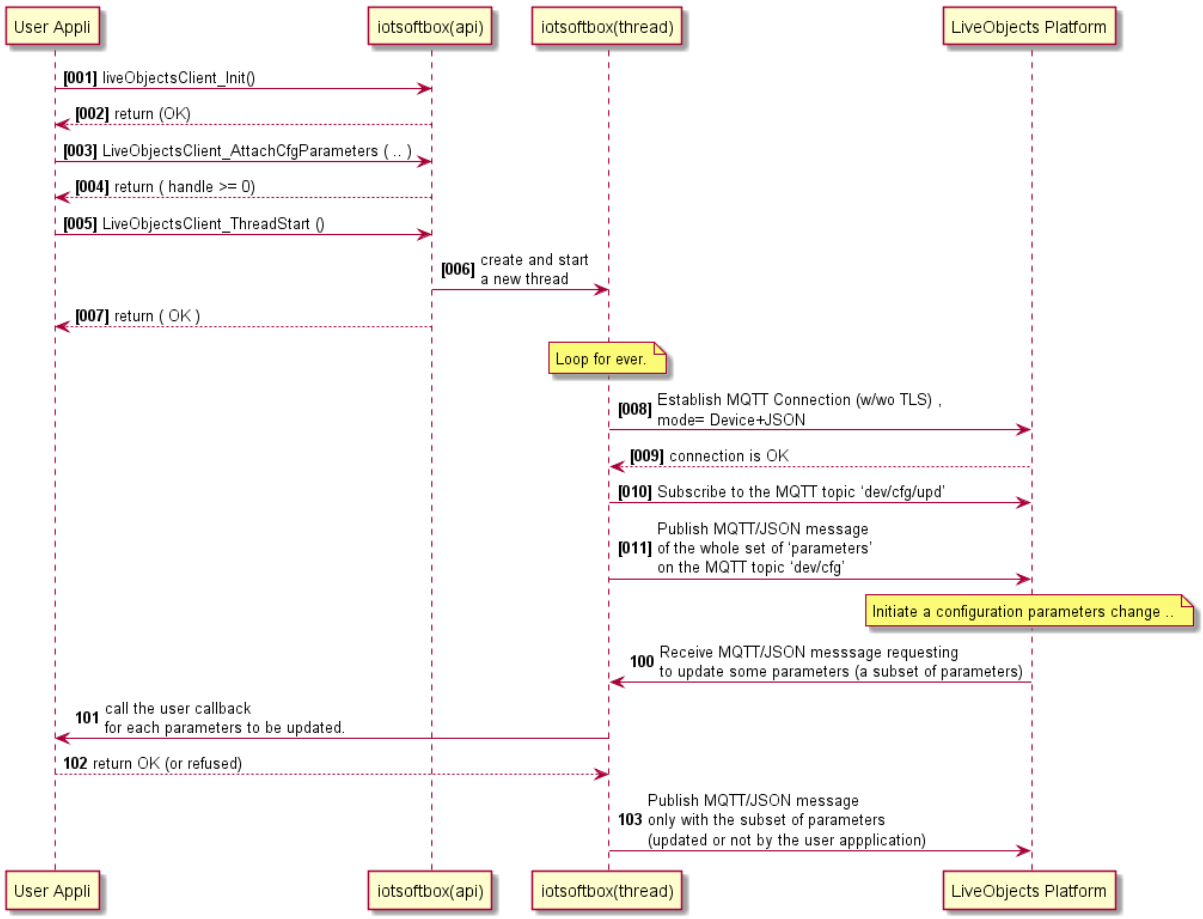
```
int LiveObjectsClient_PushCfgParams(void);
```

4.6.3. Use of Live Objects Portal to set/change parameters

On the Datavenue Live Objects portal, the user can check the 'Parameters' of its connected device, but also change these initial values:



4.6.4. Sequence Diagram



4.7. Collected Data

The device can declare one or many Live Objects "*collected data*".

A collected data is defined by:

- **streamId**: identifier of the timeseries this message belongs to.
- **Value**: a set of user values (i.e.: temperature ...)
- **Additional (and optional) information associated to this data stream:**
  - **model**: a string identifying the schema used for the "value" part of the message, to avoid conflict at data indexing,
  - **tags**: list of strings associated to the message to convey extra-information.
- At each message published to the Live Objects platform, optional information
  - **timestamp**: data/time associated with the message (using ISO 8601 format). If the timestamp is not specified, the data will be timestamped at the receipt by the Live Objects platform.
  - **latitude, longitude**: details of the geo location associated with the message (in degrees).

4.7.1. Attach a set of collected data

At any moment, application can declare/attach one or many set of 'collected data' to the iotsoftbox-mqtt library by calling the function:

```
int LiveObjectsClient_AttachData(
        uint8_t prefix,
        const char* stream_id,
        const char* model, const char* tags,
        const LiveObjectsD_GpsFix_t* gps_ptr,
        const LiveObjectsD_Data_t* data_ptr, int32_t data_nb);
```

When there is no error, the function returns a handle (positive or null value) of the collected data stream.

In the sample application:

```
appv_hdl_data = LiveObjectsClient_AttachData(
        STREAM_PREFIX, "LO_sample_measures",
        "mV1", "\"Test\"", NULL, appv_set_measures, SET_MEASURES_NB);
```

Where:

```
LiveObjectsD_Data_t appv_set_measures[] = {
        { LOD_TYPE_UINT32, "counter", &appv_measures_counter },
        { LOD_TYPE_INT32, "temperature", &appv_measures_temp },
        { LOD_TYPE_FLOAT, "battery_level", &appv_measures_volt }
};
#define SET_MEASURES_NB (sizeof(appv_set_measures) / sizeof(LiveObjectsD_Data_t))
```

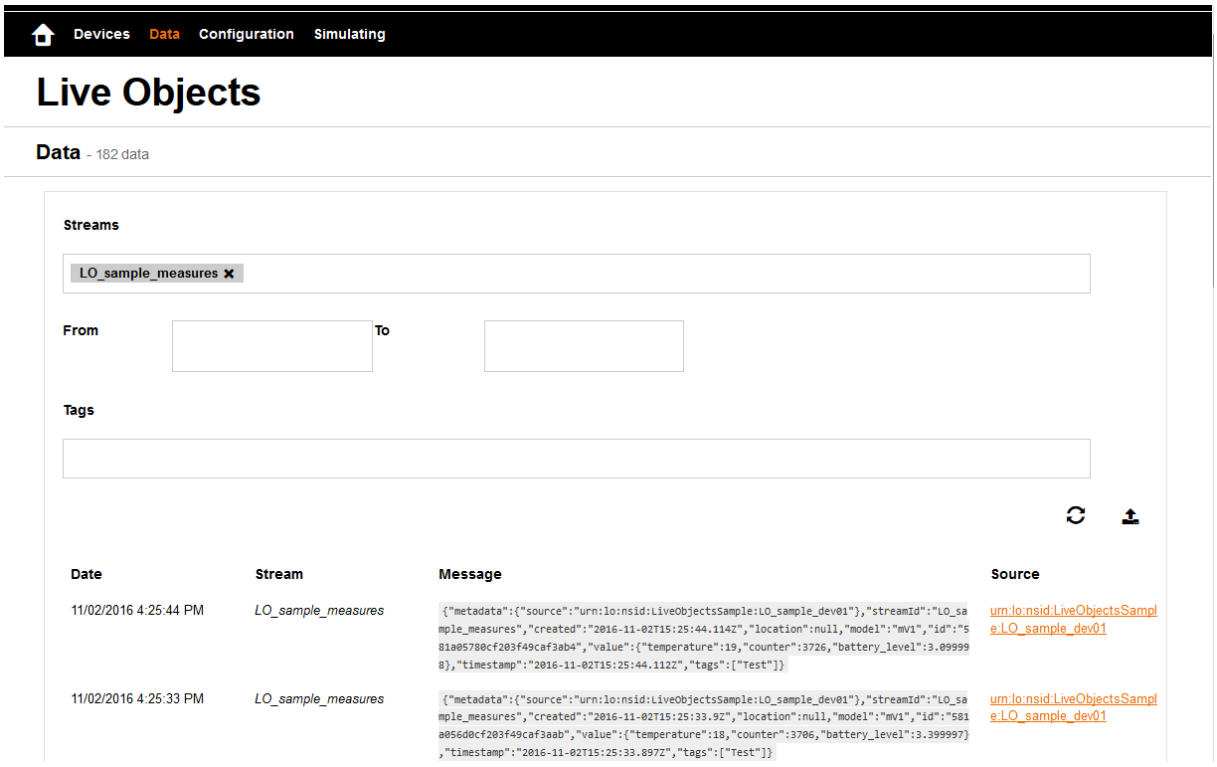
4.7.2. Push the set of collected data

When 'collected data' must be *published*, the application must call the `LiveObjectsClient_PushData ( )` function to notify the Datavenue LiveObjects platform (publishing a MQTT/JSON message on the dev/data topic):

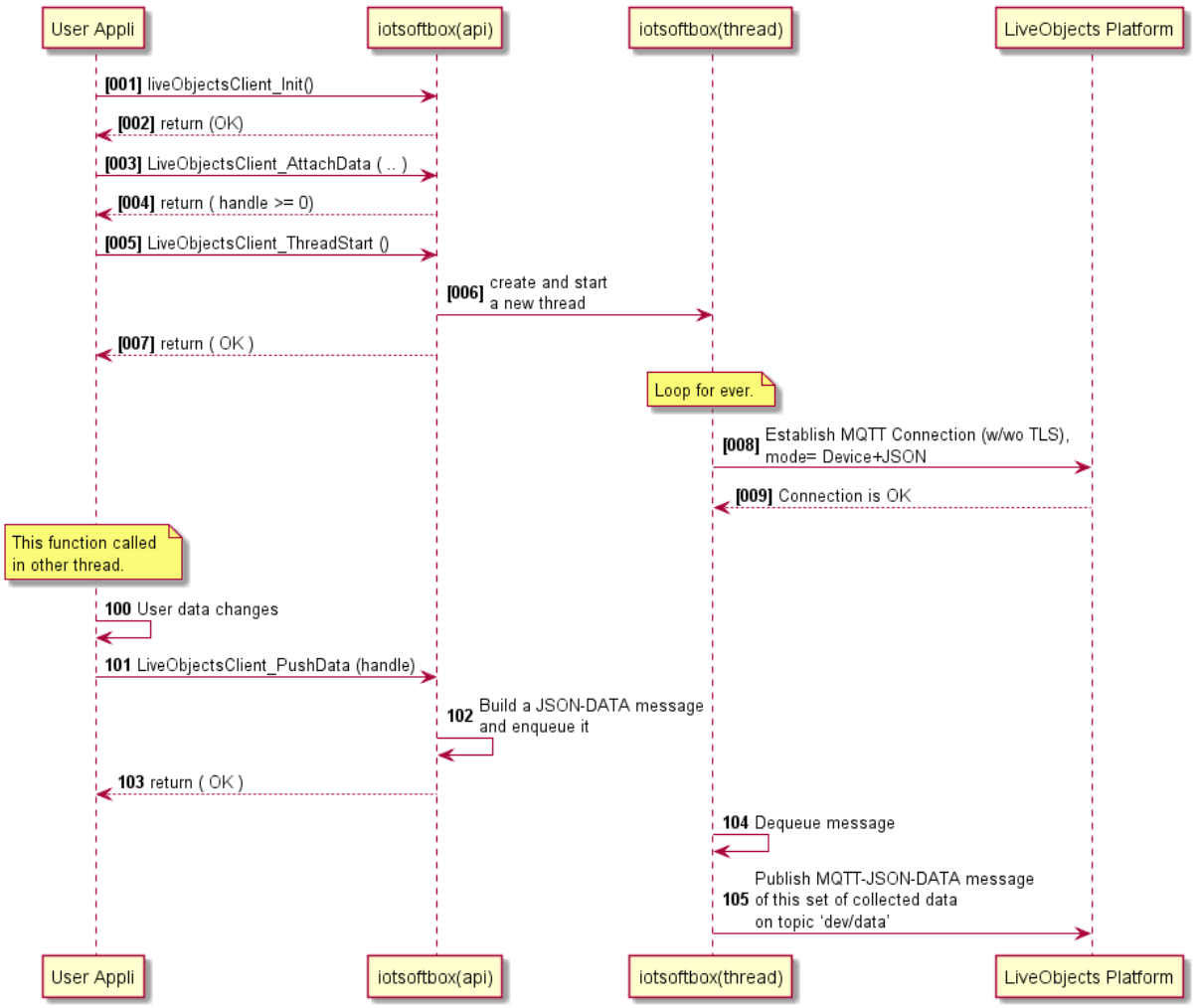
```
LiveObjectsClient_PushData(appv_hdl_data);
```

4.7.3. Use of Live Objects Portal to view data stream

On the Datavenue Live Objects portal, the user can check the 'Collected Data' published by its connected device (here, filter is set to get only stream = LO_sample_measures):



4.7.4. Sequence Diagram



4.8. Commands

4.8.1. Attach a set of commands

At any moment, the application can attach/declare only one set (or group) of 'commands' that the device is able to process. For that, the application calls the function:

```
int LiveObjectsClient_AttachCommands(
        const LiveObjectsD_Command_t* cmd_ptr,
        int32_t cmd_nb,
        LiveObjectsD_CallbackCommand_t callback);
```

In the sample application:

```
 ret = LiveObjectsClient_AttachCommands(appv_set_commands, SET_COMMANDS_NB,
main_cb_command)
```

Where:

1. The set of 'commands' is defined by an array of `LiveObjectsD_Command_t` elements. In the sample application:

```
#define CMD_IDX_RESET 1
#define CMD_IDX_LED 2

LiveObjectsD_Command_t appv_set_commands[] = {
        { CMD_IDX_RESET, "RESET", 0 },
        { CMD_IDX_LED, "LED", 0 }
};
#define SET_COMMANDS_NB (sizeof(appv_set_commands) / sizeof(LiveObjectsD_Command_t))
```

2. The application specifies the callback function (i.e. `commandCb`) which will be called when a command is received from the Live Objects platform.

```
int main_cb_command(LiveObjectsD_CommandRequestBlock_t *pCmdReqBlk) {
        int ret;
        const LiveObjectsD_Command_t *cmd_ptr;

        … // Check input param

        cmd_ptr = pCmdReqBlk->hd.cmd_ptr;

        switch (cmd_ptr->cmd_uref) {
        case CMD_IDX_RESET:  // RESET
                ret = main_cmd_doSystemReset(pCmdReqBlk);
                break;
        case CMD_IDX_LED:  // LED
                ret = main_cmd_doLED(pCmdReqBlk);
                break;
        default:
                ret = -4;
        }
        return ret;
}
```

In the callback you can define the behavior of the application regarding the command called.

4.8.2. Enable/disable 'command' feature

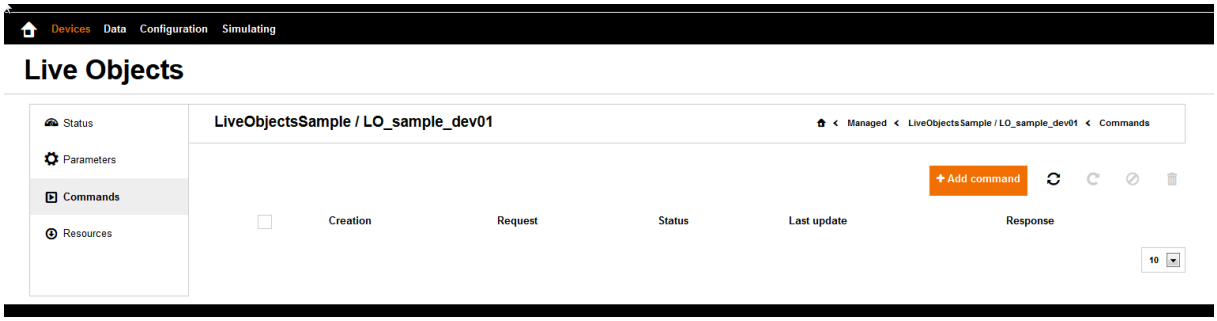
As soon as the device is ready (or not) to process commands, the application can enable (or disable) the 'command' feature by calling the function:

```
int LiveObjectsClient_ControlCommands(bool enable);
```

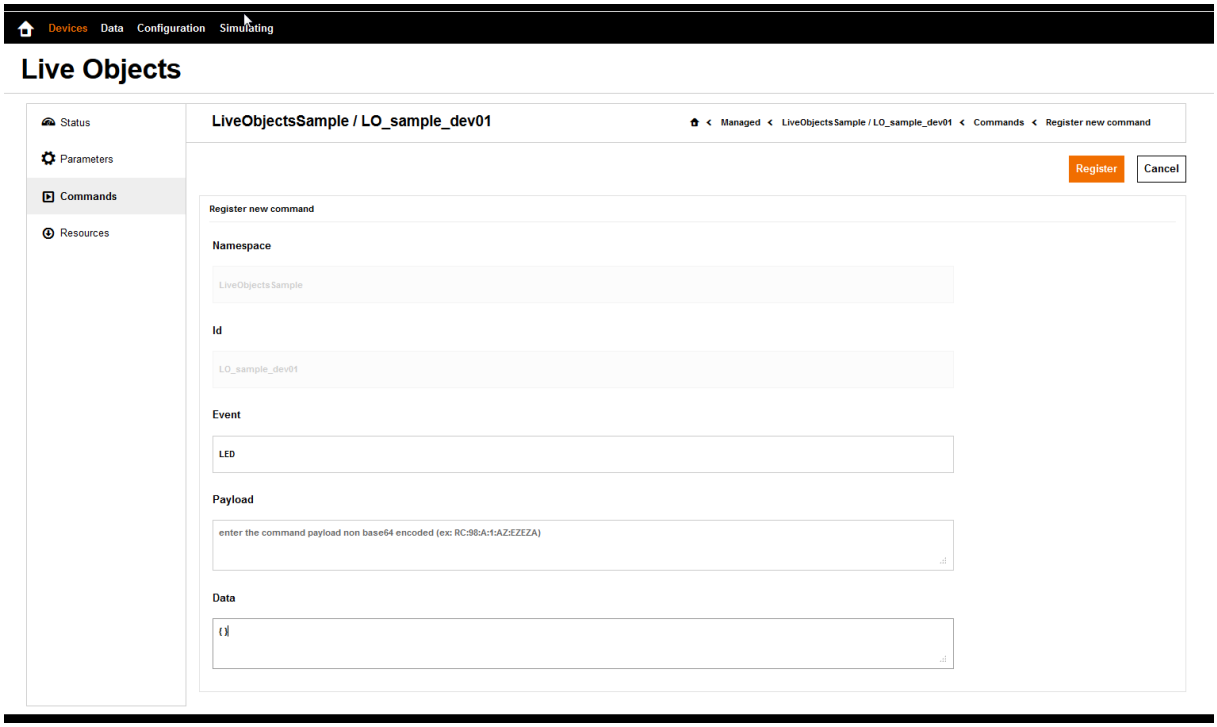
4.8.3. Use of Live Objects Portal to send a command

On the Live Objects Portal,

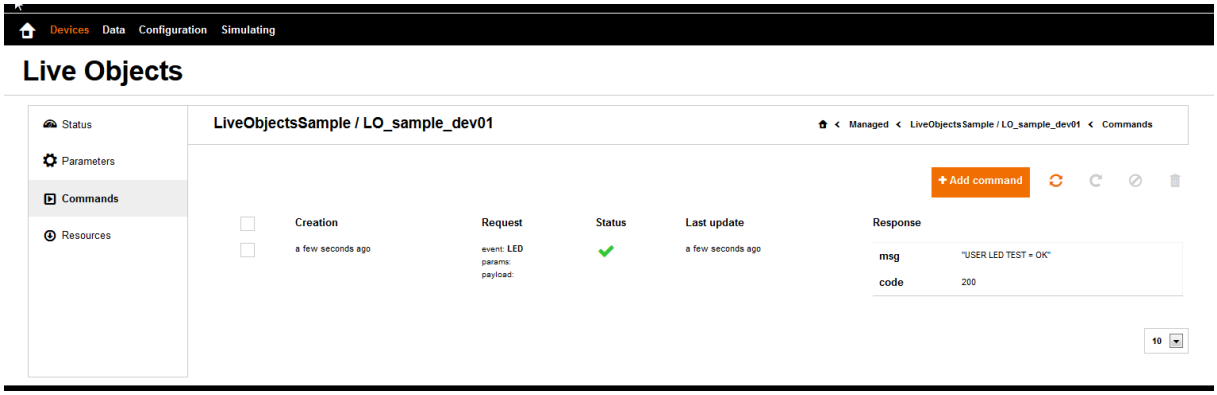
- Go to tab: Devices -> <your device> -> Commands



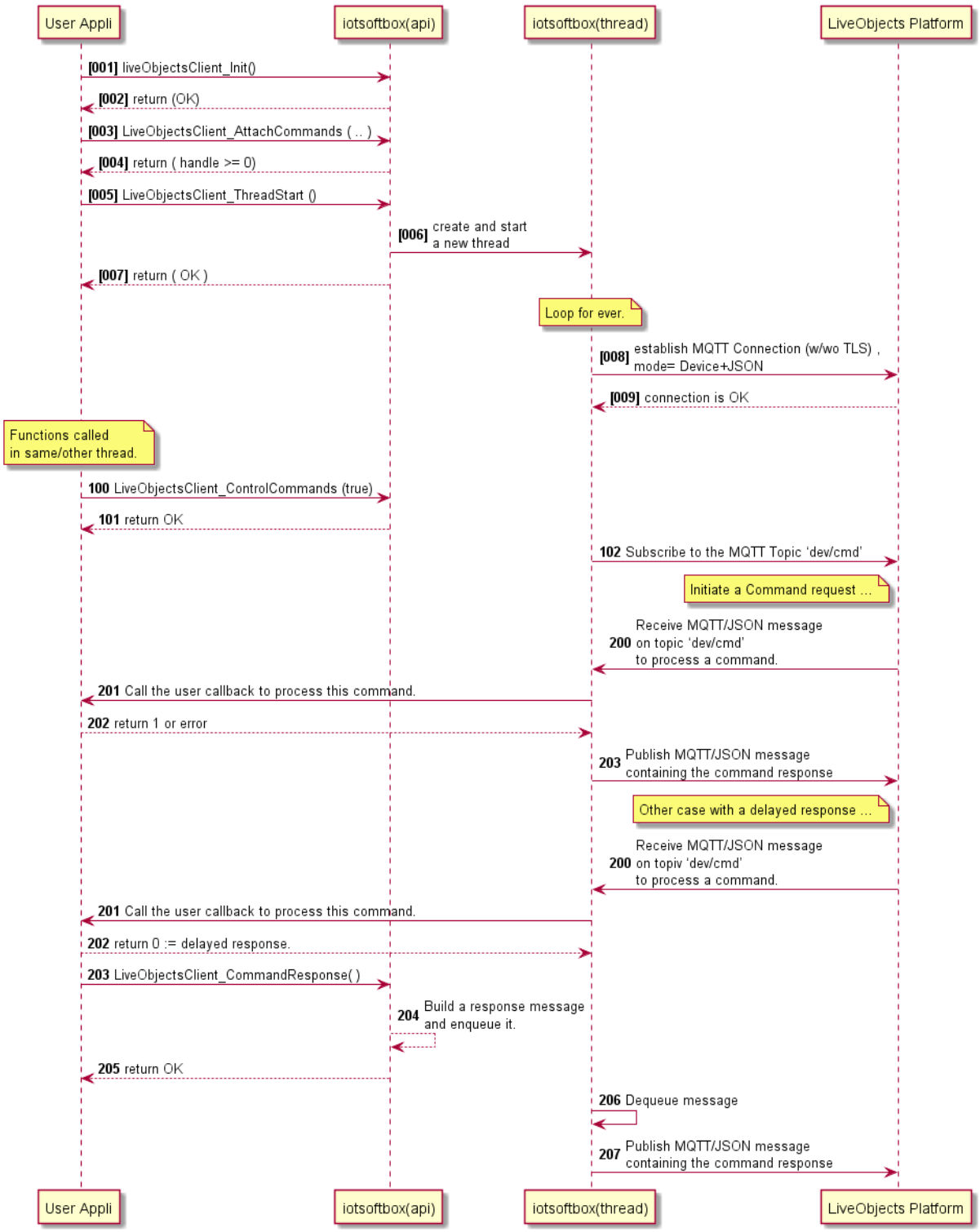
- Click on button '+ Add command"



- Click on button 'Register'. And wait a few moment , refresh the web page



4.8.4. Sequence Diagram



4.9. Resources

4.9.1. Attach a set of resources

At any moment, the application can attach/declare only one set (or group) of 'resources' by calling the function:

```
int LiveObjectsClient_AttachResources(
        const LiveObjectsD_Resource_t *rsc_ptr, int32_t rsc_nb,
        LiveObjectsD_CallbackResourceNotify_t ntfyCB,
        LiveObjectsD_CallbackResourceData_t dataCB);
```

In the sample application:

```
ret = LiveObjectsClient_AttachResources(appv_set_resources, SET_RESOURCES_NB,
        main_cb_rsc_ntfy, main_cb_rsc_data);
```

Where:

1. The set of 'resources' is defined by an array of `LiveObjectsD_Resource_t` elements.

   In the sample application:

```
char appv_rv_message[10] = "01.00";
char appv_rv_image[10] = "01.00";

#define RSC_IDX_MESSAGE 1
#define RSC_IDX_IMAGE 2

/// Set of resources
LiveObjectsD_Resource_t appv_set_resources[] = {
        { RSC_IDX_MESSAGE, "message", appv_rv_message, sizeof(appv_rv_message) - 1 },
        { RSC_IDX_IMAGE, "image", appv_rv_image, sizeof(appv_rv_image) - 1 }
};
#define SET_RESOURCES_NB (sizeof(appv_set_resources)/sizeof(LiveObjectsD_Resource_t))
```

2. The application specifies a first callback function (i.e. `resourceCb`) called by the iotsoftbox-mqtt library:
   - When a transfer request is received from the Live Objects platform
   - When the transfer is completed (with/without error)

   In the sample application:

```
LiveObjectsD_ResourceRespCode_t main_cb_rsc_ntfy(uint8_t state,
        const LiveObjectsD_Resource_t *rsc_ptr,
        const char *version_old,
        const char *version_new, uint32_t size) {

        LiveObjectsD_ResourceRespCode_t ret = RSC_RSP_OK;  // OK to update the resource

        if ((rsc_ptr) && (rsc_ptr->rsc_uref > 0) && (rsc_ptr->rsc_uref <=
                SET_RESOURCES_NB)) {
                if (state) {
                        if (state == 1) {  // Completed without error
                                …
                        } else { // Completed with error
                                …
                        }
                        appv_rsc_offset = 0;
                        appv_rsc_size = 0;

                        // Push Status (message has been updated or not)
                        LiveObjectsClient_PushStatus(appv_hdl_status);
                } else {
                        appv_rsc_offset = 0;
                        ret = RSC_RSP_ERR_NOT_AUTHORIZED;
                        switch (rsc_ptr->rsc_uref) {
                        case RSC_IDX_MESSAGE:
                                if (size < (sizeof(appv_status_message) - 1)) {
                                        ret = RSC_RSP_OK;
                                }
                                break;
                        case RSC_IDX_IMAGE:
                                if (size < (sizeof(appv_rsc_image) - 1)) {
                                        ret = RSC_RSP_OK;
                                }
                                break;
                        }
                        if (ret == RSC_RSP_OK) { // Initialize the transfer
                                appv_rsc_size = size;
                        } else { // Transfer is refused
                                appv_rsc_size = 0;
                        }
                }
        } else {
                ret = RSC_RSP_ERR_INVALID_RESOURCE;
        }
        return ret;
}
```

In this callback you can handle the app behavior for each declared resource.

3. The application specifies a second callback function to receive the data from the Live Objects platform.

   In the sample application:

```
int main_cb_rsc_data(const LiveObjectsD_Resource_t *rsc_ptr, uint32_t offset) {
	int ret;

	if (rsc_ptr->rsc_uref == RSC_IDX_MESSAGE) {
		char buf[40];
		if (offset > (sizeof(appv_status_message) - 1)) {
			return -1;
		}
		ret = LiveObjectsClient_RscGetChunck(rsc_ptr, buf, sizeof(buf) - 1);
		if (ret > 0) {
			if ((offset + ret) > (sizeof(appv_status_message) - 1)) {
				return -1;
			}
		}
	} else if (..) {
		…
	} else {
		ret = -1;
	}
	return ret;
}
```

In this callback, you can receive the data. You can get the data in one time if you have set a big enough buffer or in severals time if you're using a very low capacity device. Once you have the data you can process them.

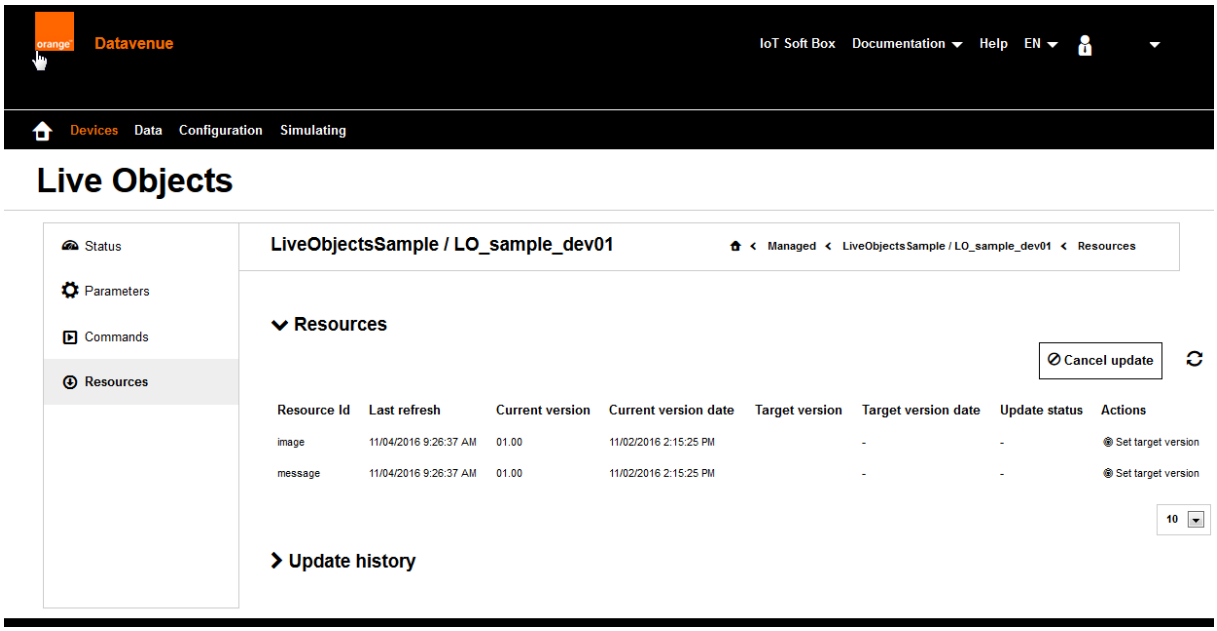
4.9.2. Enable/disable 'resources' feature

As soon as the device is ready (or not) to process the resource update request, the application can enable (or disable) the 'resources' feature by calling the function:

```
int LiveObjectsClient_ControlResources(bool enable);
```

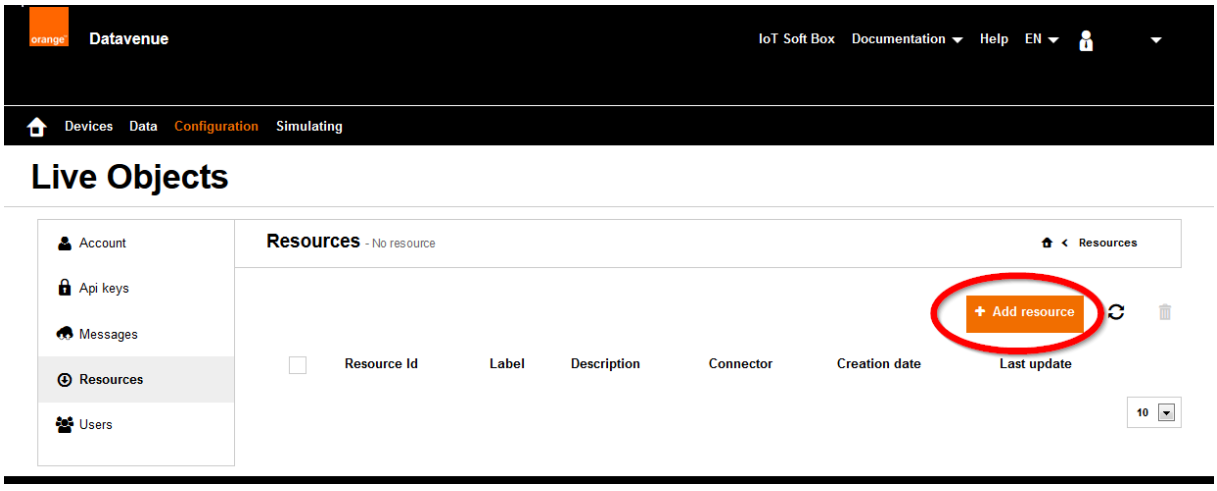
4.9.3. Use of Live Objects Portal to create and update a resource

The first step is to check the list of resources declared by the Live Objects device.



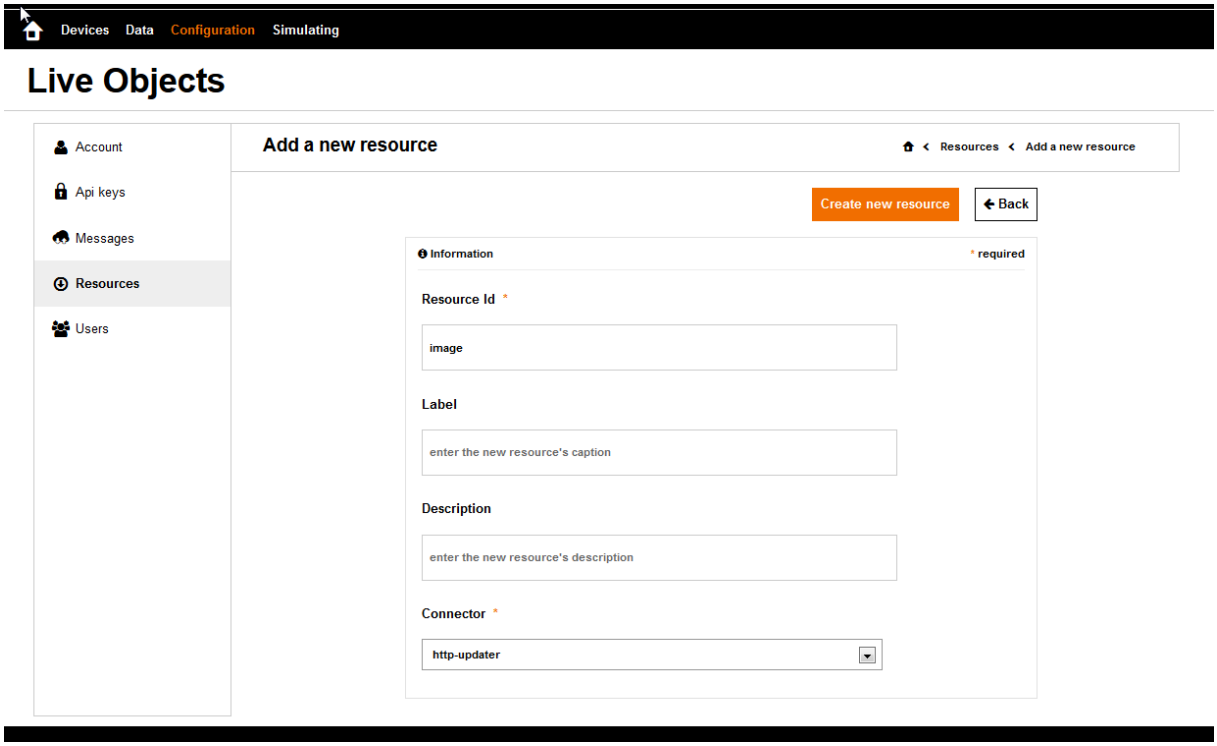
Here, the device 'LiveObjectsSample/LO_sample_dev01' has two resources identified by: *image* and *message*.

Now, the user can create a new resource on the Live Objects platform, in the tab 'Configuration->Resources', associated to these resources

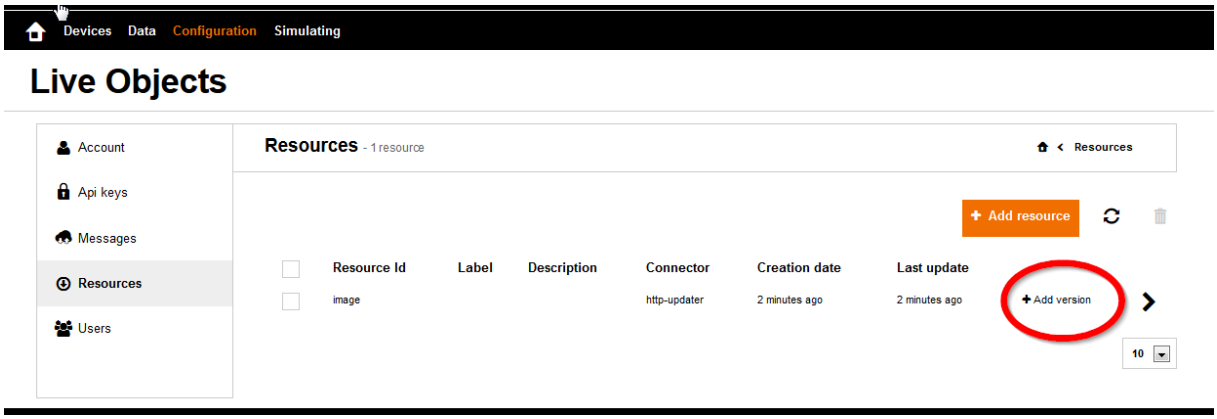


Two fields are mandatory

- Resource Id: set to 'image', resource identified by the device.
- Connector: set to http-updater.

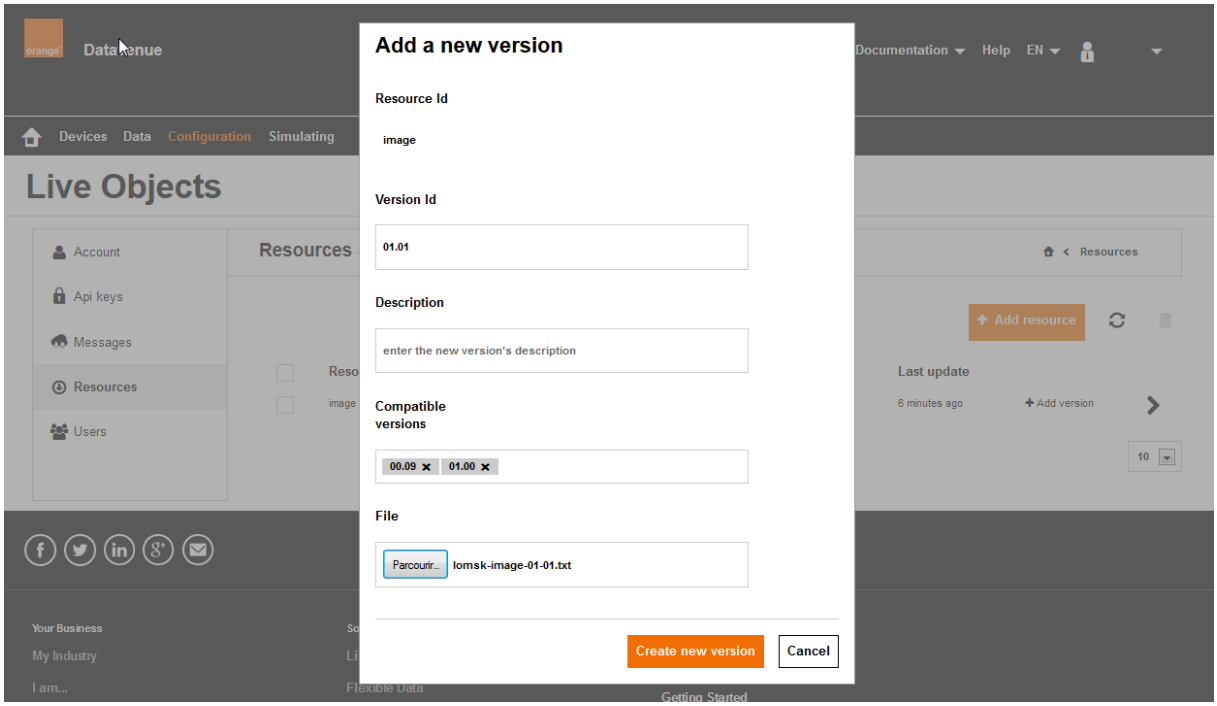


The result is the following:



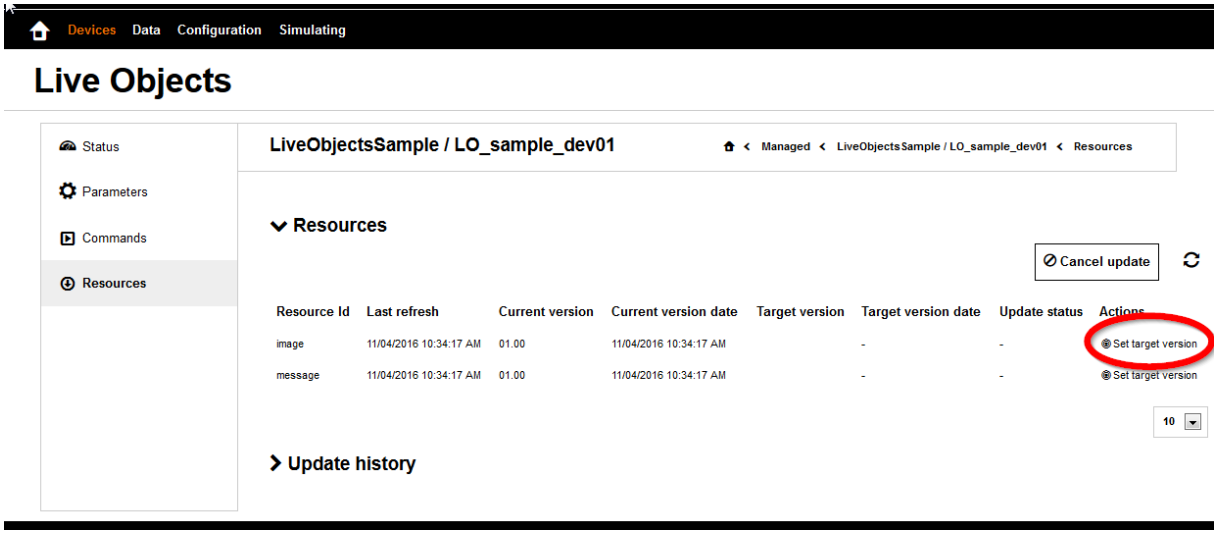
Then, a new resource version can be attached to this resource 'image', by specifying:

- Version id (i.e. 01.01) for this resource to download on devices
- Compatible versions (optional): the list of current versions deployed on devices which must be able to accept this new version (01.01).
- File, to download on the device

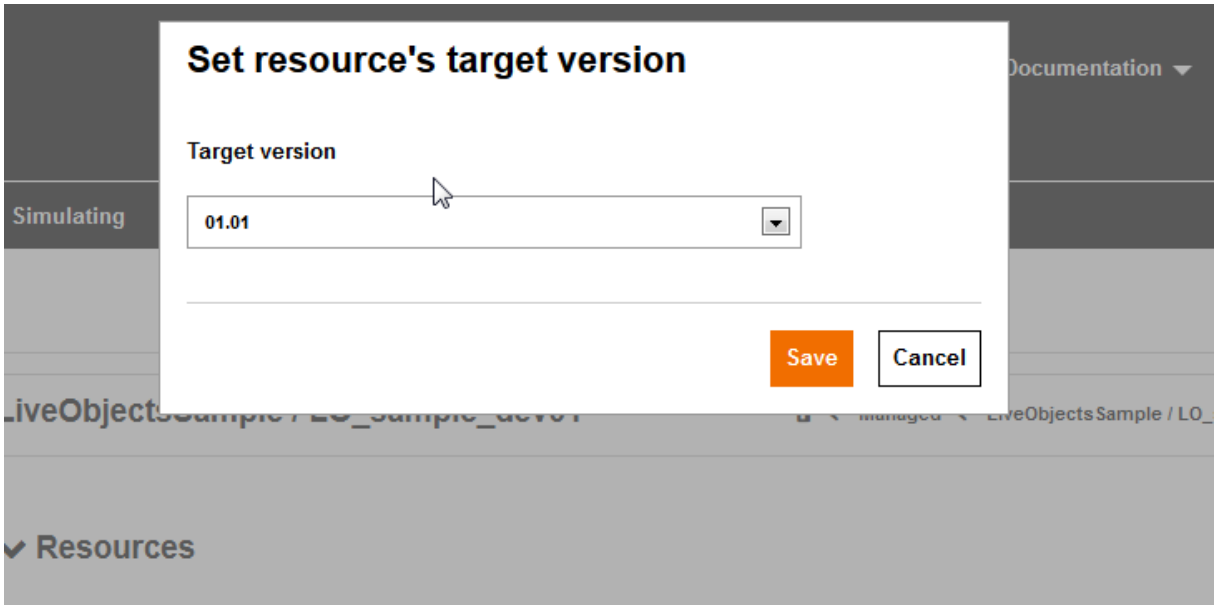


Now, the resource update request can be launched for this device:

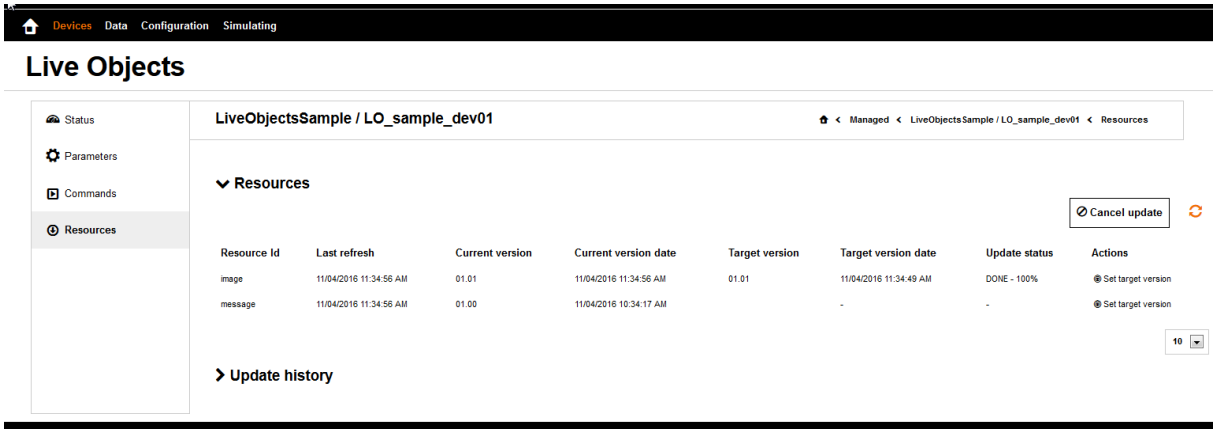
- Go to the ‘devices’ tab.
- Select your connected device, here it is “LiveObjectsSample / LO_sample_dev01”
- Go to the ‘resources’ tab



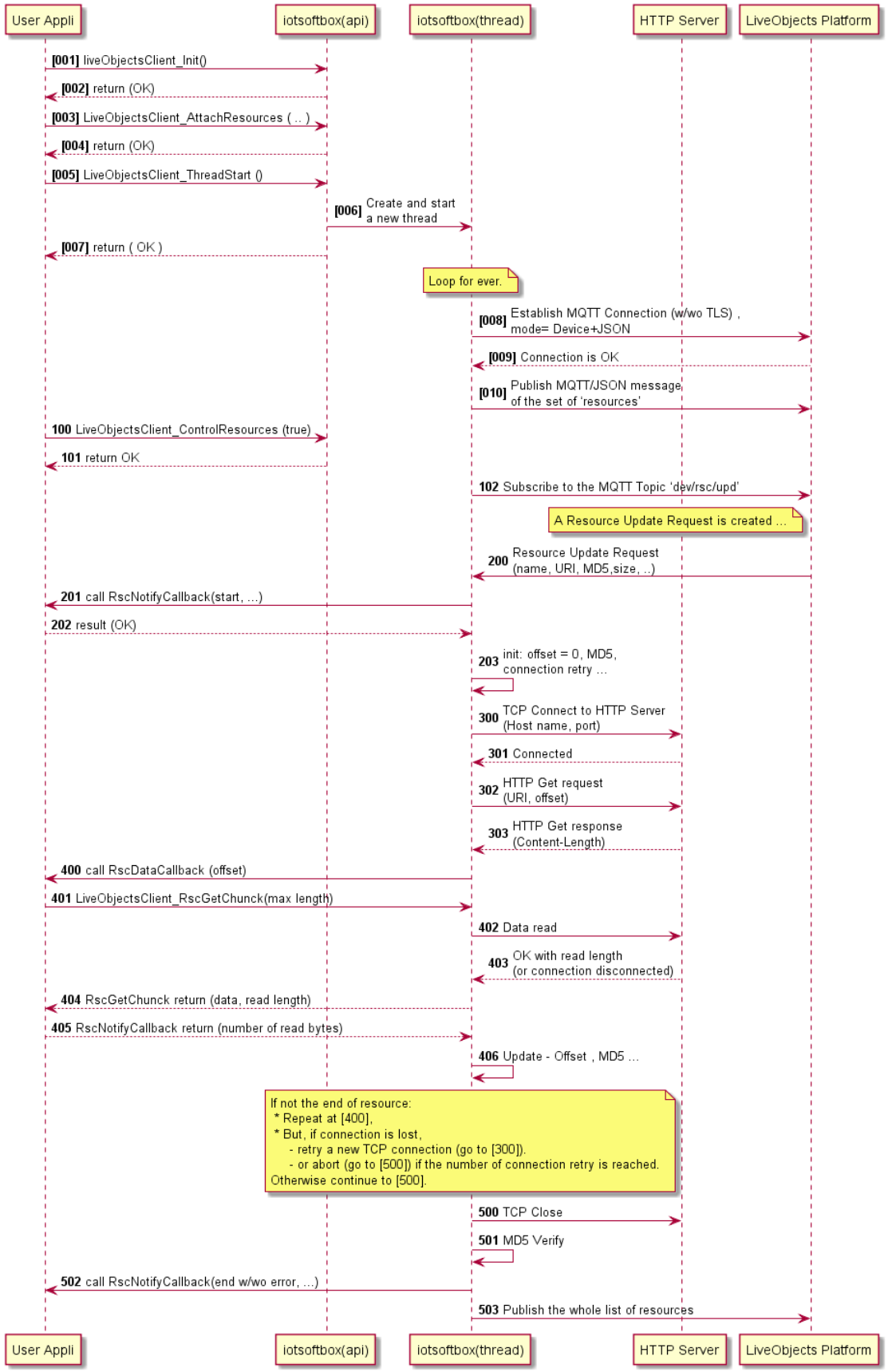
- Click on ‘Set target version’
- And select the resource version to download on device

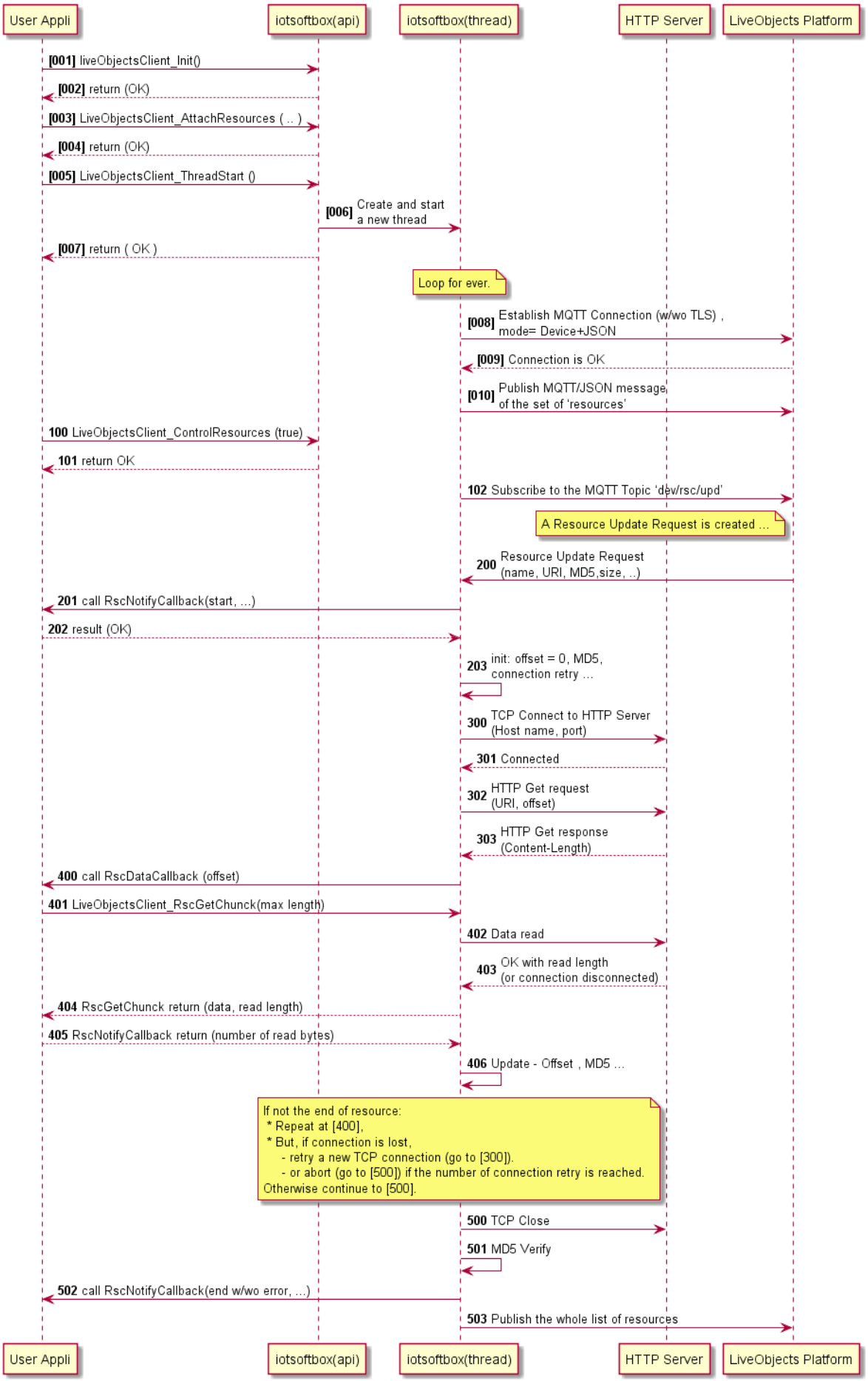


At the end of transfer, after refreshing the web page, the current version should be equal to the target version:



4.9.4. Sequence diagram




User Appli
iotsoftbox(api)
iotsoftbox(thread)
HTTP Server
LiveObjects Platform
[001] liveObjectsClient_Init()
[002] return (OK)
[003] LiveObjectsClient_AttachResources (..)
[004] return (OK)
[005] LiveObjectsClient_ThreadStart ()
[006] Create and start a new thread
[007] return (OK)
Loop for ever.
[008] Establish MQTT Connection (w/wo TLS) , mode= Device+JSON
[009] Connection is OK
[010] Publish MQTT/JSON message of the set of 'resources'
100 LiveObjectsClient_ControlResources (true)
101 return OK
102 Subscribe to the MQTT Topic 'dev/rsc/upd'
A Resource Update Request is created ...
200 Resource Update Request (name, URI, MD5,size, ..)
201 call RscNotifyCallback(start, ...)
202 result (OK)
203 init: offset = 0, MD5, connection retry ...
300 TCP Connect to HTTP Server (Host name, port)
301 Connected
302 HTTP Get request (URI, offset)
303 HTTP Get response (Content-Length)
400 call RscDataCallback (offset)
401 LiveObjectsClient_RscGetChunck(max length)
402 Data read
403 OK with read length (or connection disconnected)
404 RscGetChunck return (data, read length)
405 RscNotifyCallback return (number of read bytes)
406 Update - Offset , MD5 ...
If not the end of resource:
* Repeat at [400],
* But, if connection is lost,
- retry a new TCP connection (go to [300]).
- or abort (go to [500]) if the number of connection retry is reached.
Otherwise continue to [500].
500 TCP Close
501 MD5 Verify
502 call RscNotifyCallback(end w/wo error, ...)
503 Publish the whole list of resources
User Appli
iotsoftbox(api)
iotsoftbox(thread)
HTTP Server
LiveObjects Platform

An example of URI is:
http://liveobjects.orange-business.com:80/dl/18p1bj775jhk0pj6p49076hk45

And the header of HTTP Get Response is similar to:

```
HTTP/1.1 200 OK
Server: nginx/1.4.6 (Ubuntu)
Date: Fri, 04 Nov 2016 10:34:50 GMT
Content-Type: application/force-download; charset=UTF-8
Content-Length: 1974
Connection: close
X-Application-Context: lo-http-updater:prod:8080
Access-Control-Allow-Headers: X-Requested-With, Content-Type
Access-Control-Allow-Credentials: true
```

5. Additional Information

5.1. Doxygen documentation

The iotsoftbox-mqtt library is documented using the Doxygen source code comments (mainly for the '*public'* header files).

To generate the documentation, download doxygen then under Linux use the following command:

```
doxygen mqtt_live_objects/iotsoftbox-mqtt-core/doxygen/liveobjects_iotsoftbox.doxyfile
```

The doc will be generate into an apidoc folder. Open `apidoc/html/index.html` to start browsing the doc.

You can also use a GUI (on linux it's called doxywizard).

Step 1: Specify the working directory.

Step 2: Stay in the **Wizard** tab, fill the fields from the **Project** topic, then go to the output topic, uncheck **LaTeX** unless you want it. then go to the **Run** tab and press **Run Doxygen.**

The doc will be in the directory you specified in the **Project** topic.

5.2. Debug

The iotsoftbox-mqtt library uses MACRO definitions to print traces. Theses MACROs are defined in the **loc_trace.h** header file depending on platform.

- `LOTRACE_ERR`
- `LOTRACE_WARN`
- `LOTRACE_INF`
- `LOTRACE_DBG`
- `LOTRACE_DBG_VERBOSE`

5.2.1. Linux environment

The `LOTRACE_xxx` MACROs are mapped onto printf function defined in <stdio.h>

As an alternative you can log everything into the syslog of your device. To do so, go into **liveobjects_dev_param.h** and switch **#define SYSLOG 0** to **1.**

5.3. IoT Soft Box Library Configuration

The iotsoftbox-mqtt library can be tuned according to the target and/or application constraints (memory, network, use or not of Live Objects features...) All tunable parameters are defined with theirs default values in the header file **liveobjects-client/LiveObjectsClient_Config.h**.

Then, the user application can overwrite theses values in the header file **liveobjects_dev_config.h**

Tunable parameters are:

- LOC_FEATURE_MBEDTLS
  Implement or not the mbedtls feature
- LOC_FEATURE_LO_STATUS
  Support or not the Live Objects 'Status' feature.
- LOC_FEATURE_LO_PARAMS
  Support or not the Live Objects 'Configuration Parameters' feature.
- LOC_FEATURE_LO_DATA
  Support or not the Live Objects 'Collected Data' feature.
- LOC_FEATURE_LO_COMMANDS
  Support or not the Live Objects 'Commands' feature.
- LOC_FEATURE_LO_RESOURCES 1
  Support or not the Live Objects 'resources' feature.
- LOC_SERV_TIMEOUT
  Connection Timeout in milliseconds (default 20 seconds)
- LOC_MQTT_API_KEEPALIVEINTERVAL_SEC
  Period of MQTT Keepalive message (default: 30 seconds)
- LOC_MQTT_DEF_SND_SZ
  Size (in bytes) of static MQTT buffer used to send a MQTT message (default: 2 K bytes)
- LOC_MQTT_DEF_RCV_SZ
  Size (in bytes) of static MQTT buffer used to receive a MQTT message (default: 2 K bytes)
- LOC_MQTT_DEF_TOPIC_NAME_SZ
  Max Size (in bytes) of MQTT Topic name (default: 40 bytes)
- LOC_MQTT_DEF_DEV_ID_SZ
  Max Size (in bytes) of Device Identifier (default: 20 bytes)
- LOC_MQTT_DEF_NAME_SPACE_SZ
  Max Size (in bytes) of Name Space (default: 20 bytes)
- LOC_MQTT_DEF_PENDING_MSG_MAX
  Max Number of pending MQTT Publish messages (default: 5 messages)
- LOC_MAX_OF_COMMAND_ARGS
  Max Number of arguments in command (default: 5 arguments)
- LOC_MAX_OF_DATA_SET
  Max Number of collected data streams (or also named 'data sets') (default: 5 data streams)
- LOM_JSON_BUF_SZ
  Size (in bytes) of static JSON buffer used to encode the JSON payload to be sent (default: 1 K bytes)
- LOM_JSON_BUF_USER_SZ
  Size (in bytes) of static JSON buffer used to encode a user JSON payload (default: 1 K bytes)