NXP IoT – Weather Station User Guide

1. Introduction

Contents

NXP's Rapid IoT prototyping kit is a comprehensive, secure and optimized IoT end node solution with a user-friendly development environment that enables anyone to quickly take their idea to a proof-of-concept. Its architecture is built upon two controllers:

- Kinetis K64F for the main application, powered by an ARM® Cortex®-M4 core
- Kinetis KW41Z for wireless connectivity, powered by an ARM® Cortex®-M0+ core

It includes:

- 10-axis motion sensing thanks to a combo accelerometer / magneto-meter
- Gyroscope
- Pressure sensor for altitude measurement
- Environmental sensing via temperature/humidity, ambient light and air quality sensors
- Display capabilities with low-power color screen
- Authentication, identification
- User interfaces with LEDs, buzzer and touch plus push buttons
- Additional memory for data storage
- Rechargeable battery

The factory application includes USB and Bluetooth/Thread bootloaders to program your own firmware without external tool, and several IoT application use-cases leveraging components on board.

In order to allow any user to evaluate this product, NXP has created the “NXP IoT – Weather station” applications. This is a set of applications consisting of a mobile application (available in Android and iOS), a cloud application and a demo FW for the Rapid IoT device.

The usage of the mobile and cloud applications is described in detail in this document. In brief, the main idea of this set of applications is to get values of some of the sensors contained in the Rapid IoT kits. These values are sent via Bluetooth from the Rapid IoT devices and received in the mobile application. The mobile application is able to send the measurements to a cloud service. The user is then able to visualize and plot the measurements on the cloud.

Before using the Rapid IoT devices with the provided applications, it is necessary to flash them with the corresponding firmware. Instructions to flash a device are:

- **Connect** one end of the provided **USB cable to the computer** and the other end to the micro USB type-B **connector of the SLN-RPK-NODE**
- Keep **SW3 button pressed** while pushing shortly **SW5/Reset** button,
- Wait 1-2s for RGB LED to blink Green, then **release SW3** button

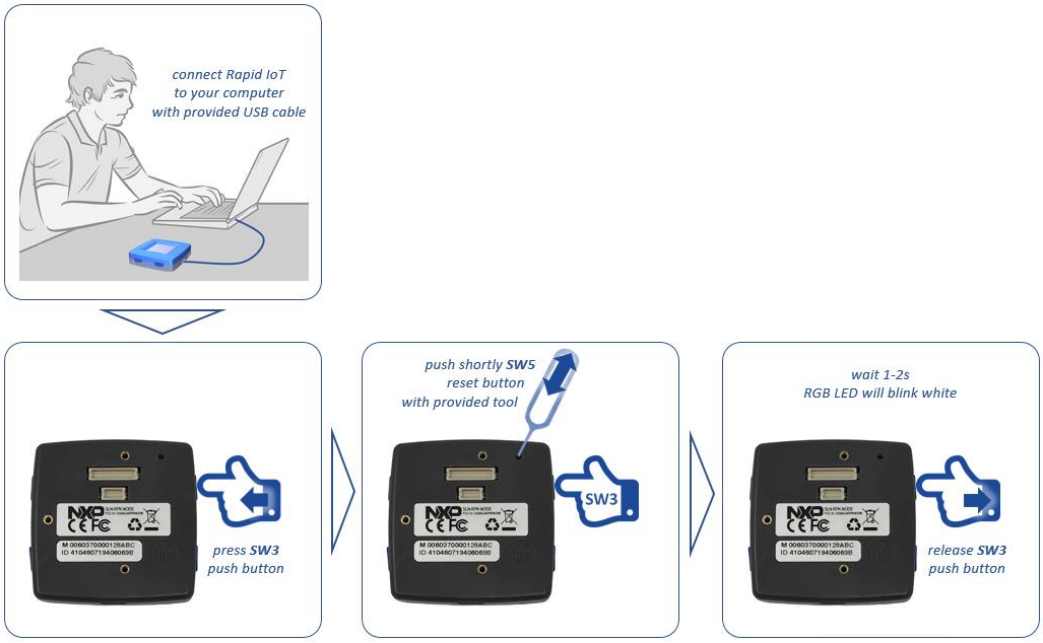

Figure 1. Instructions for USB Mass Storage Device Programming

RGB LED will blink green and your computer will detect a new Mass Storage drive and automatically install the appropriate drivers

- From your computer file explorer, drag-n-drop or copy-paste into the Mass Storage drive the Weather station demo binary file.

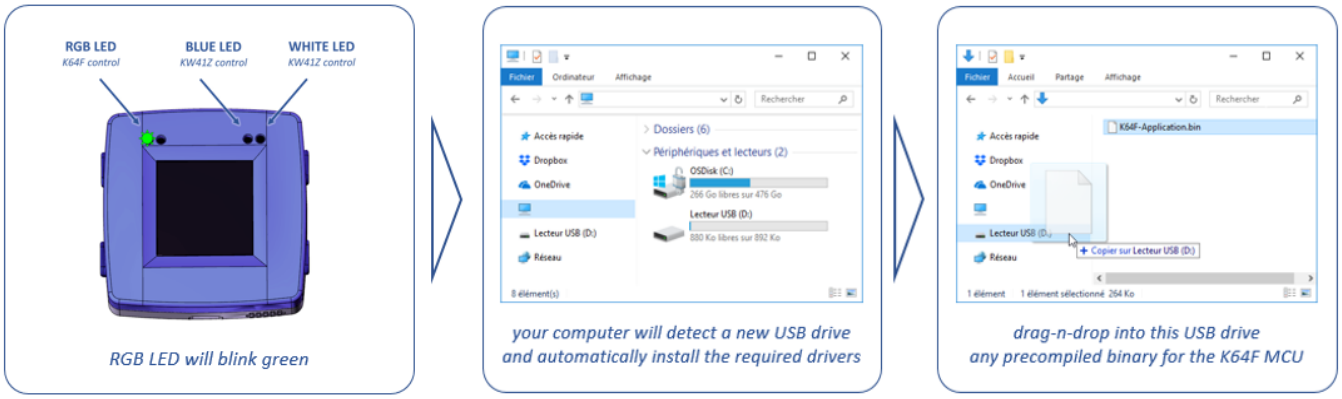

Figure 2. Instructions for pushing a new application through USB

Bootloader will automatically identify the MCU target to re-program thanks to the binary file signature.
RGB LED will **blink purple** during download and **blink blue** during serial flash programming.
RGB LED will **blink green** during K64F internal flash (re)programming with the new application (read from Serial Flash memory) and automatically reset, when ready.

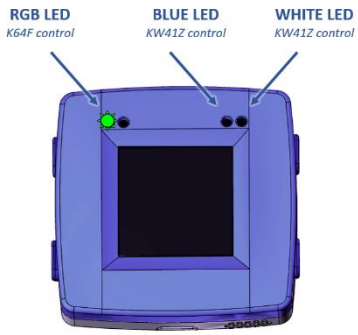

Figure 3. USB Programming LED

RGB LED	BLUE LED	WHITE LED
PURPLE BLINK	OFF	OFF
BLUE BLINK	OFF	OFF
GREEN BLINK	OFF	OFF

Table 1. K64F USB Programming LED Sequence

More information about the Rapid IoT kit can be found in NXP's website:
https://www.nxp.com/support/developer-resources/rapid-prototyping/nxp-rapid-iot-prototyping-kit:IOT-PROTOTYPING

2. Mobile applications

Download applications

The Android and iOS applications are available in their respective stores with the name “NXP IoT – Weather station”. Figure 4 shows the application in both stores.

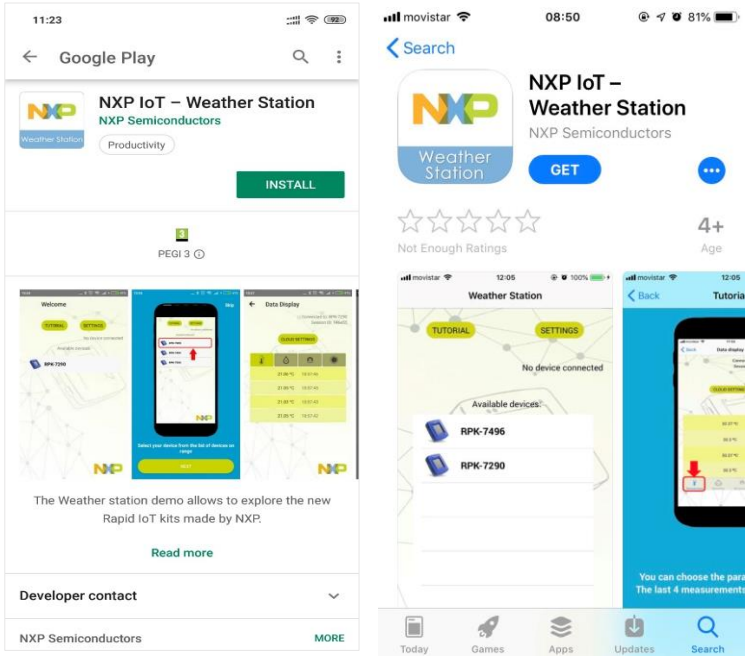

Figure 4. NXP IoT – Weather station in the stores

Minimum requirements

The mobile device intended to work with the application must have Bluetooth Low Energy (BLE) capabilities.

Apart from BLE characteristics, it is mandatory to have an internet connection in order to connect to the Cloud application and send the measurements data there. If there is no internet connection, the application will continue working but sending the measurements data to the cloud application will not be possible

For both Bluetooth and internet connections, there is a detection mechanism at the beginning of the application that will notify the user to activate any of these features if they appear to be turned off or the device doesn't support them.

The minimum OS versions are 4.4 for Android and 9 for iOS.

The iOS and Android apps have been tested in the following devices:

- iPhone X (iOS 12.1.2)
- iPhone 8 (iOS 12.1.2)
- Samsung Galaxy S9 (Android 8.0)
- Nexus 5X (Android 8.1.0)
- Sony Xperia Z1 (Android 5.1.1)
- Xiaomi MI6 (Android 8.1.0)

Applications flow

For a better understanding of the application flow, Figure 5 shows a block diagram with the main parts of the application.

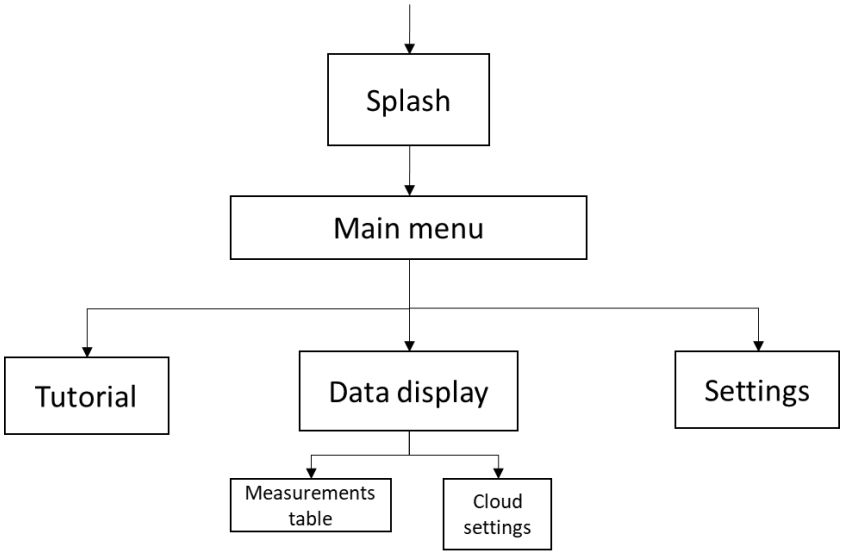

Figure 5. Mobile application flow diagram

At startup the splash screen is displayed for two seconds. The splash screen can be seen in Figure 6.

Figure 6. Splash screen

When the splash screen disappears, the application moves to the Main menu. In this menu the user can see the available Rapid IoT devices displayed in a table. In the main menu it is also possible to see the Tutorial and go to the application Settings. Figure 7 shows the main menu of the app.

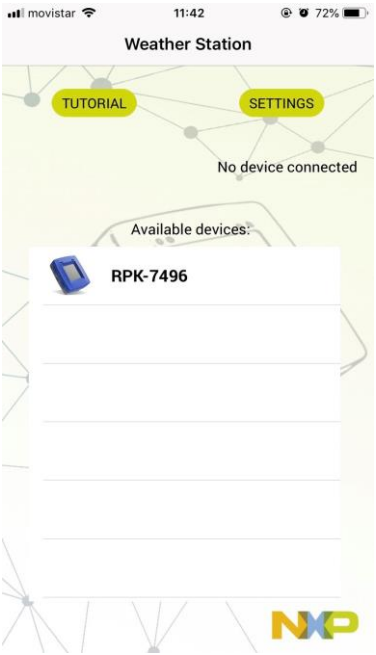

Figure 7. Main menu

By clicking on any available device, a new session will start. Each time a new session begins, a session ID is randomly generated. This session ID will be used later in the Cloud application for login purposes.

When a device is connected, the Data display view is opened. In this view the last 4 measurements of the Temperature, Humidity, Air pressure and Ambient light sensors are shown in a table.

By default, the measurements are sent to the cloud application, but there is an option to disable posting the data to the cloud application and also to delete the database for the current session. These options can be accessed with the ‘Cloud Settings’ button which is available in the Data display view.

Figure 8 shows a couple of screenshots for the Data display view showing the Temperature and Humidity tables.

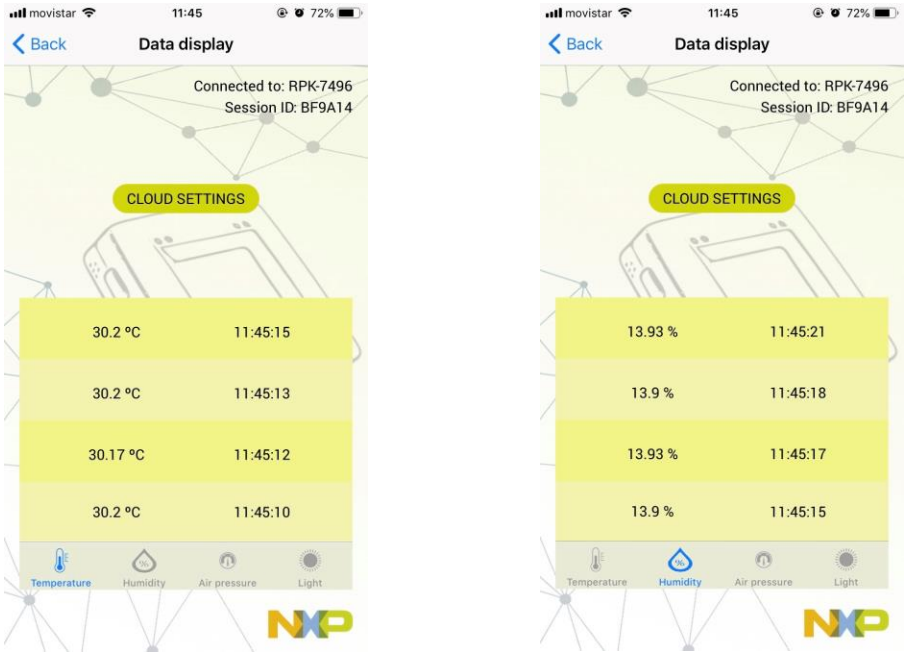

Figure 8. Data display in mobile apps

As previously stated, the Cloud settings allow the user to enable/disable posting the measurements data to the cloud application and to clear the database. This menu can be seen in Figure 9.

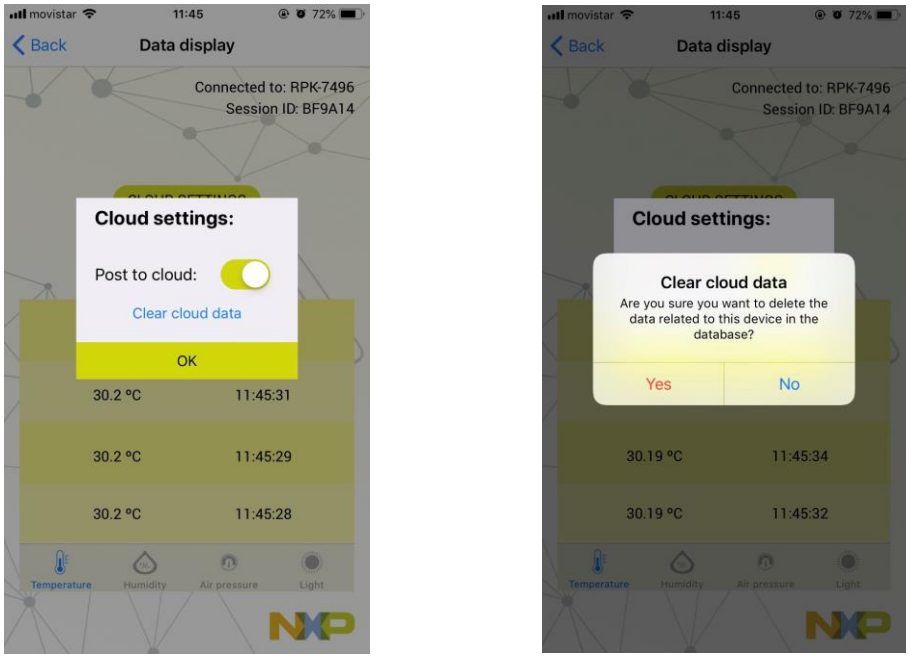

Figure 9. Cloud settings

By pressing the 'Back' button in the Data display view, the application moves to the main menu but the connection with the device remains active. In fact, the connected device will appear in a different color in the devices table.

Some application options can be changed in the Settings menu. The data refresh rate will be 'Fastest' by default. This means that the data will be refreshed in the measurements table every second. On the other hand, setting the data refresh rate to 'Slowest' will refresh the data every minute.

To find a more detailed explanation of the Settings menu, please go to Section 2.5. The Settings menu can be seen in Figure 10.

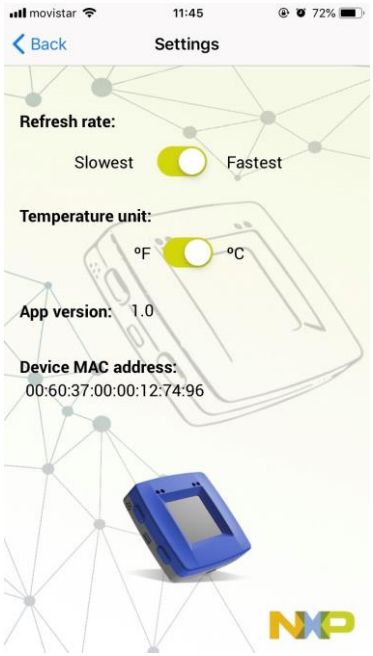

Figure 10. Settings menu

Finally, the tutorial can also be accessed from the Main menu. The tutorial will show a carousel of images with the basic functionalities of the app. Figure 11 shows some screenshots of the tutorial.

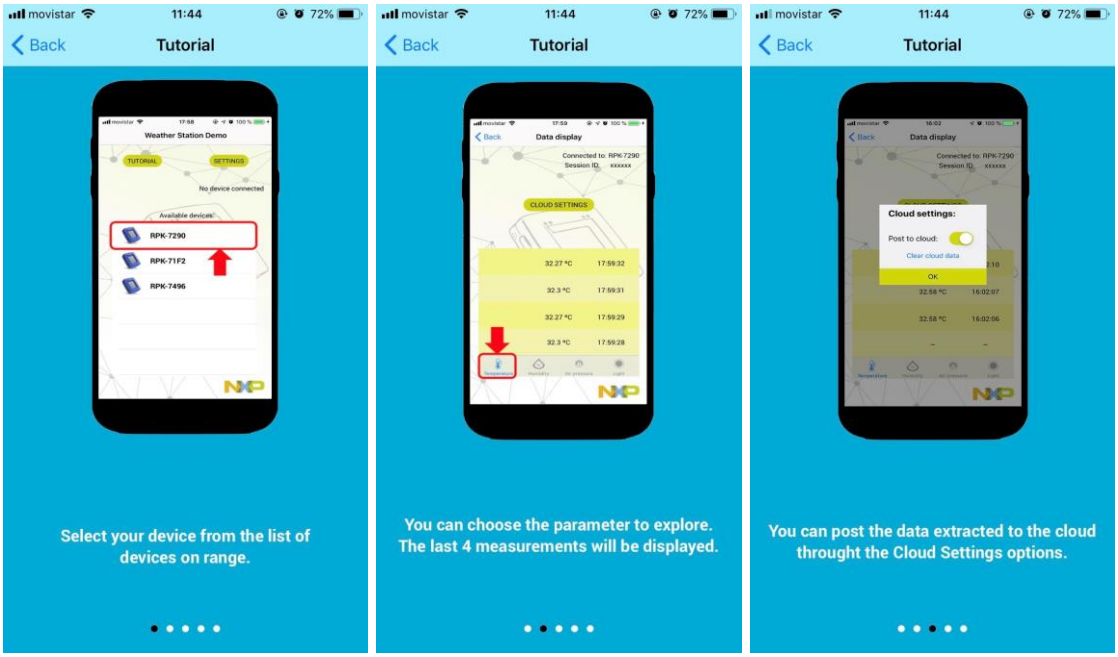

Figure 11. Tutorial

Data displayed

As introduced in the previous section, the application receives four different types of data from the Rapid IoT device:

- Temperature
- Humidity
- Air pressure
- Ambient light

The Rapid IoT FW reads one of these measurements every 300 ms and sends each measurement through their corresponding Bluetooth characteristic. The mobile applications are subscribed to these Bluetooth characteristics and will update the data in the application every time a new characteristic is written.

In the Data display menu, it is possible to switch between the last 4 measurements of each sensor. Figures 12-15 show screenshots corresponding to each measurement.

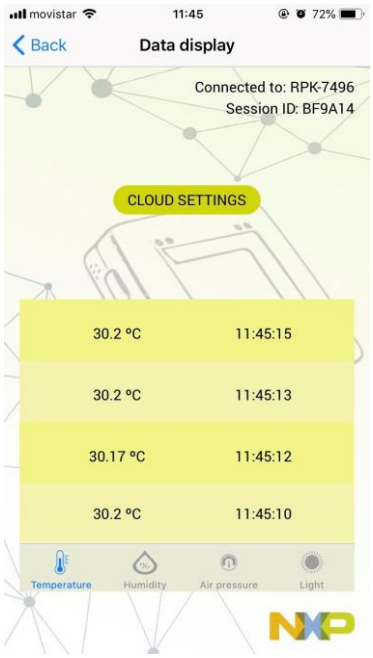

Figure 12. Temperature display

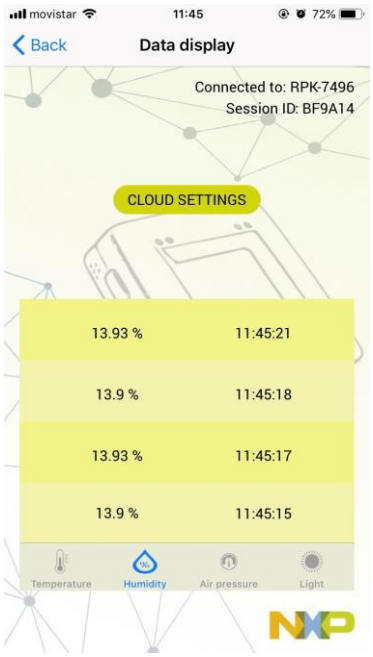

Figure 13. Humidity display

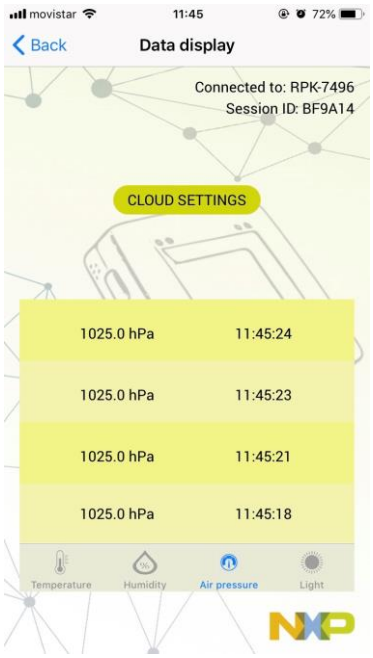

Figure 14. Air pressure display

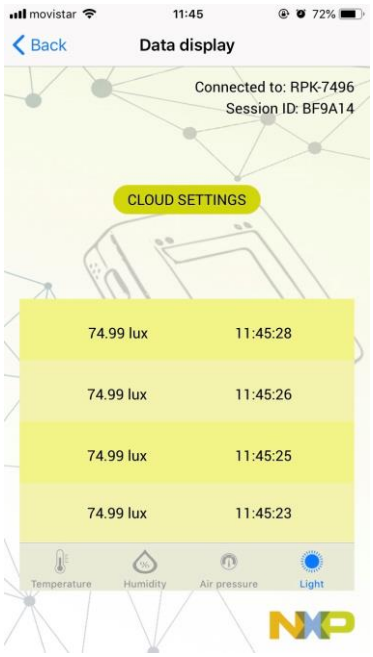

Figure 15. Ambient light display

Regarding the measurement units, the temperature table can be displayed in either Celsius or Fahrenheit degrees. The default option is Celsius degrees. The temperature unit can be changed in the Settings menu.

The remaining measurements have fixed units:

- Humidity in Relative humidity (%)
- Air pressure in hectoPascal (which corresponds to 100 Pascal)

- Ambient light in lux (corresponds to 1 lm/m^2)

For more details regarding the code implementation, please refer to the Developer Guide. There you can find the application source code for retrieving the measurement from the sensors and sending them to the cloud application.
iOS app repository link: https://bitbucket.org/mobileknowledge/weather_station_demo-iosapp/src/master/
Android app repository link: https://bitbucket.org/mobileknowledge/weather_station_demo-androidapp/src/master/

Settings menu

In the Weather station app there are two different menus to configure the application. One can be found in the Main view, containing the general settings for the application. The other configurations are the cloud settings and can only be changed if the user is connected to a Rapid IoT device, since these settings are related to the data being stored in the cloud.

2.5.1. General settings

The general settings are accessible from the Main menu. In this settings menu the user can see the application version and the MAC Address of the device. It is also possible to change the following configurations:

- Data refresh rate: This is the rate at which the mobile application stores measurements from the Rapid IoT device. There are two options:
    - Fastest: The measurements are stored every second. This is the fastest rate at which the samples are sent to the device.
    - Slowest: The measurements are only stored every minute. The remaining samples that arrive to the mobile application are discarded.
- Temperature unit: The temperature unit can be switched between Celsius and Fahrenheit degrees.

The settings menu is shown in Figure 16.

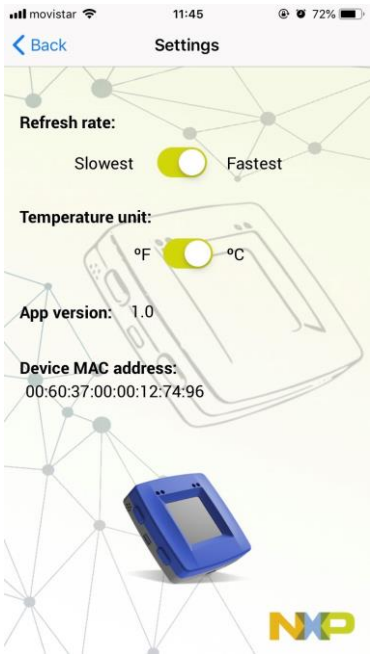

Figure 16. Settings menu when a device is connected

In case the user clicks on the Settings menu without a device connected to the mobile application, the Settings menu will hide the MAC Address. This is shown in Figure 17.

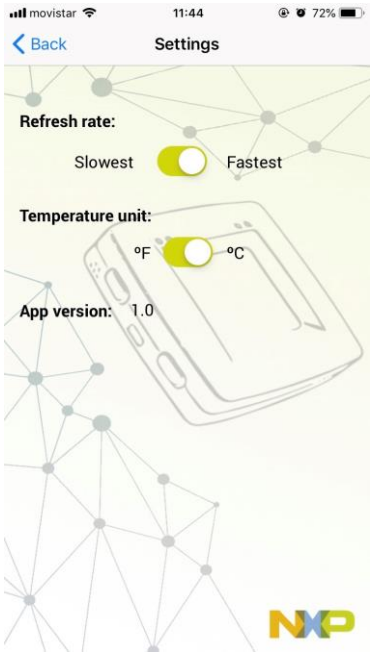

Figure 17. Settings menu when disconnected

2.5.2. Cloud settings

The cloud settings can only be modified when connected to a Rapid IoT device. By clicking the 'Cloud settings' button in the Data display screen, the cloud settings menu will open. In this menu you will find two possible settings:

- Enable/disable cloud posting: By default, posting the measurements data to the cloud application is enabled. When this option is disabled the cloud application database will not receive new measurements.
- Clear cloud data: By clicking on 'Clear cloud data', a warning message appears saying that all the measurements belonging to the current session will be deleted.

Figure 18 shows the Cloud settings menu and clear cloud data warning message.

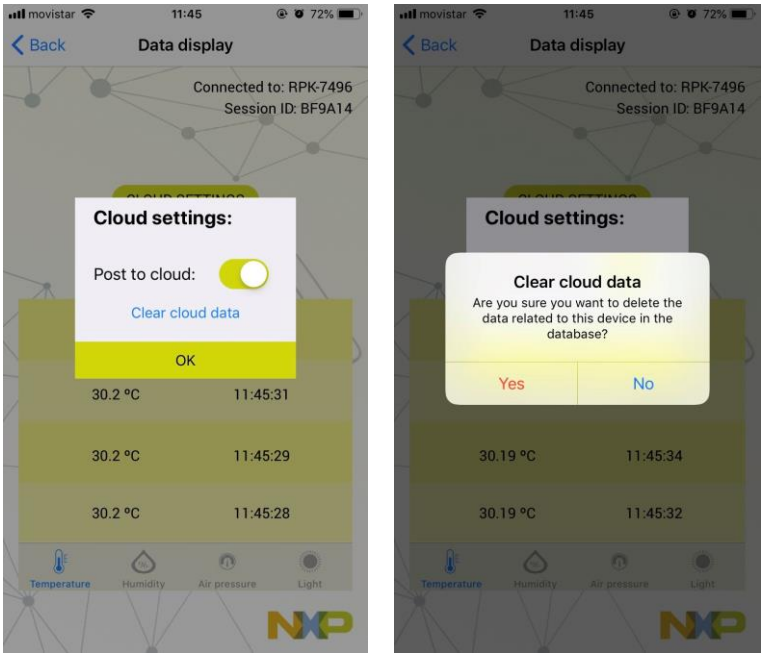

Figure 18. Cloud settings menu

3. Cloud application

Access to the cloud application

The cloud application for the Weather station demo is hosted in Amazon Web Services. To access the application, go to the following link: http://weatherstationcloudapp.us-west-2.elasticbeanstalk.com/

Minimum requirements

This application has been tested in the following web browsers:

- Google chrome version 71.0.3578.98
- Mozilla Firefox version 64.0b8

- Microsoft edge version 42.17134.1.0

Since the application uses JavaScript, it is mandatory to enable it in the web browser.

Application flow

At startup, the login page is displayed. For any user to login, it is necessary to introduce the following data:

- Last 4 digits of the MAC Address of the device. This number can be found in the mobile apps in the settings menu and also in the reverse of the Rapid IoT device as shown in Figure 19.

Figure 19. MAC Address shown in the device

- Session ID: The session ID is randomly generated each time a new device is connected in the mobile application and can be found in the Data display view. Even when the device disconnects from the mobile app the session ID will still remain valid to retrieve the measurements from the database.

The Login page is shown in Figure 20.

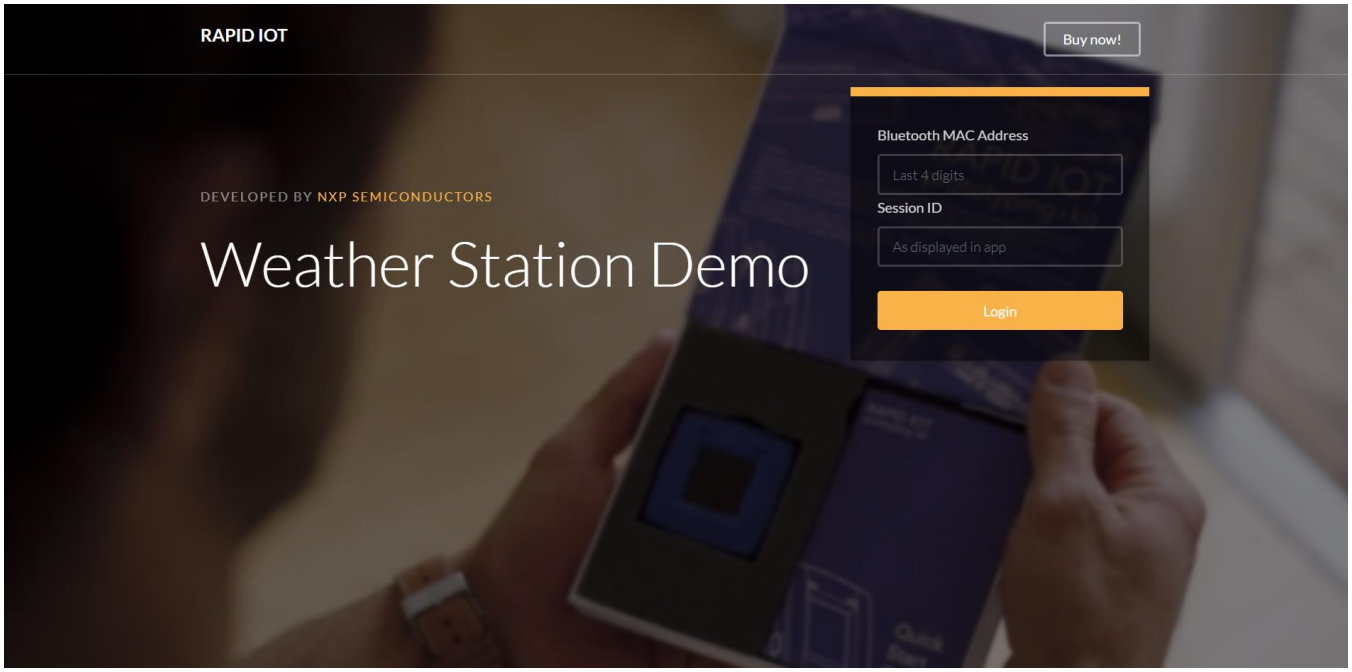

Figure 20. Cloud application – Login page

After successfully completing a login, the application will take the user to the main page. There are several useful features implemented in the main page:

- Display the measurements from the Temperature, Humidity, Air pressure and Ambient light sensors in separate graphs.
- Hide/unhide the measurements graphs.
- Export all the measurements from a session in .csv or .txt format.
- Select auto-refresh mode; in this mode the graphs will be automatically updated every 15 seconds.
- Set the timescale in seconds or minutes.
- Change the temperature unit between Celsius and Fahrenheit degrees.

Figures 21 and 22 show the main page of the cloud application and its several options.

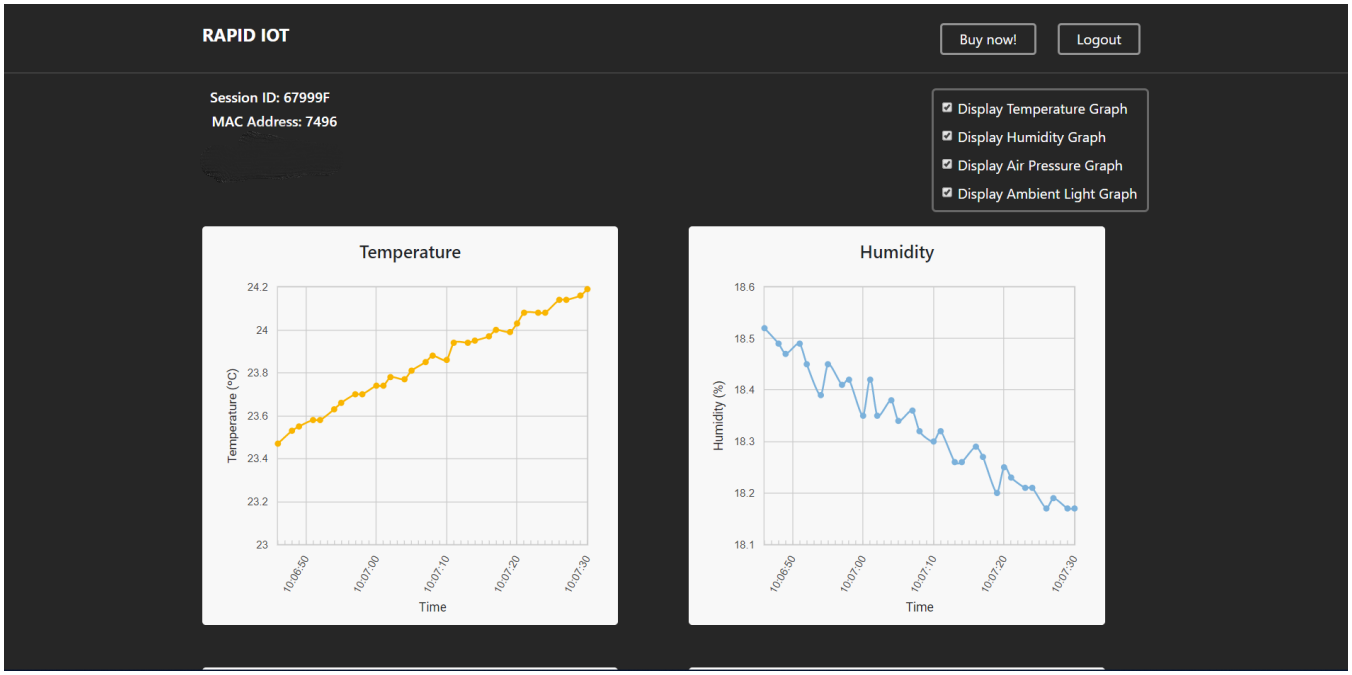

Figure 21. Cloud application – Data display (1)

Figure 22. Cloud application – Data display (2)

Finally, the logout button will close the current session and redirect the user to the index page.

Measurements data in the cloud application

As introduced in section 3.3, the main page of the cloud application has four graphs to plot each of the measurements retrieved from the device sensors.

Each graph is individual and can be shown/hidden separately from the other graphs.

Since the amount of measurements stored in the database may be very high, the graphs will only plot the last 30 measurements of the session.

In case the user desires to download all the measurements from the current session, the export button allows him to download all the measurements either in .csv or .txt format. The fields contained for each measurement in the file are described below:

- Timestamp: Unix timestamp stored in the database
- Name: Device name containing the last 4 digits of the MAC Address (e.g., RPK-7496)
- Session ID: 6 digit number
- MAC Address: Bluetooth MAC Address in EUI-64 format (e.g., 0060370000127496)
- Temperature: Temperature value in floating point with 2-digit precision in Celsius degrees.
- Humidity: Humidity value in floating point with 2-digit precision in Relative humidity.
- Air pressure: Air pressure value in floating point with 2-digit precision in hectoPascals.
- Ambient light: Ambient light value in floating point with 2-digit precision in lux.

In order to continually listen for requests from the mobile app and store the measurements in the database, a broker application has been created in an individual server instance. This application

avoids overloading the available resources in the Cloud application. The broker application implements an ActiveMQTT client which connects to an ActiveMQTT server in AWS and reads the new requests to store the new values in the database.

For more details regarding the code implementation of the cloud and broker apps, please refer to the Developer Guide.
Cloud app repository link: https://bitbucket.org/mobileknowledge/weather_station_demo-cloudapp/src/master/
Broker app repository link: https://bitbucket.org/mobileknowledge/weather_station_demo-brokerapp/src/master/

4. End-to-end example

Once the mobile and cloud applications have been presented separately, it is appropriate to show an end-to-end example with the usage of both applications together.

Connect to the Rapid IoT device

Before connecting to the Rapid IoT device, make sure that the Weather station FW is correctly flashed in the device: the blue LED is continually blinking and the device is discoverable via Bluetooth.

After checking that the Rapid IoT device is working properly and the mobile phone has the Bluetooth connectivity active, open the NXP IoT – Weather station app. The Rapid IoT device should appear in the Available devices table. See Figure 23. Click on the device in the table to trigger the connection.

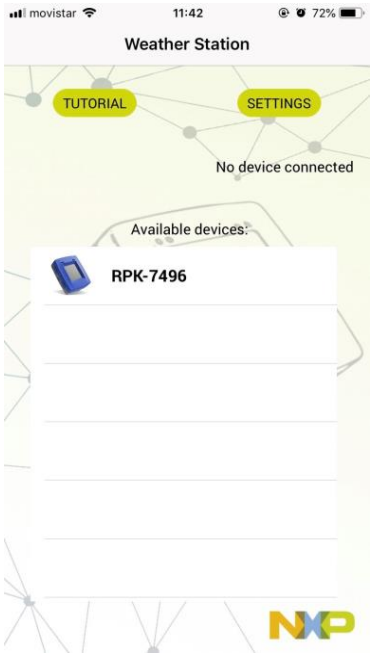

Figure 23. Discovered device in mobile app

Once the device is connected to the mobile app, the data display view is opened in the mobile app with the session ID generated. See Figure 24.

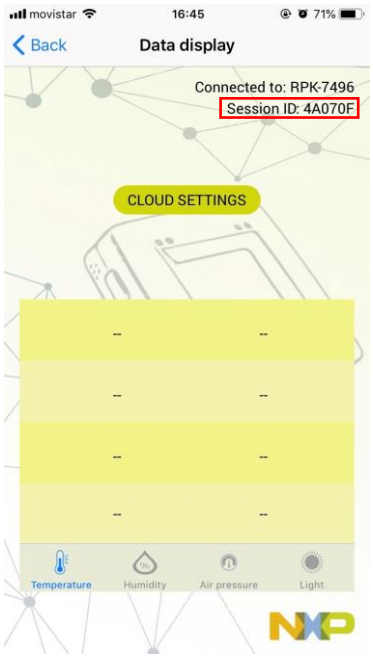

Figure 24. Data display in mobile app

Login into the cloud application

Now open the cloud application and introduce the session ID displayed in the mobile app together with the last 4 digits of the Rapid IoT device to login into the cloud application. If you don't remember how to obtain the login information, please check Section 3.3. See Figure 25.

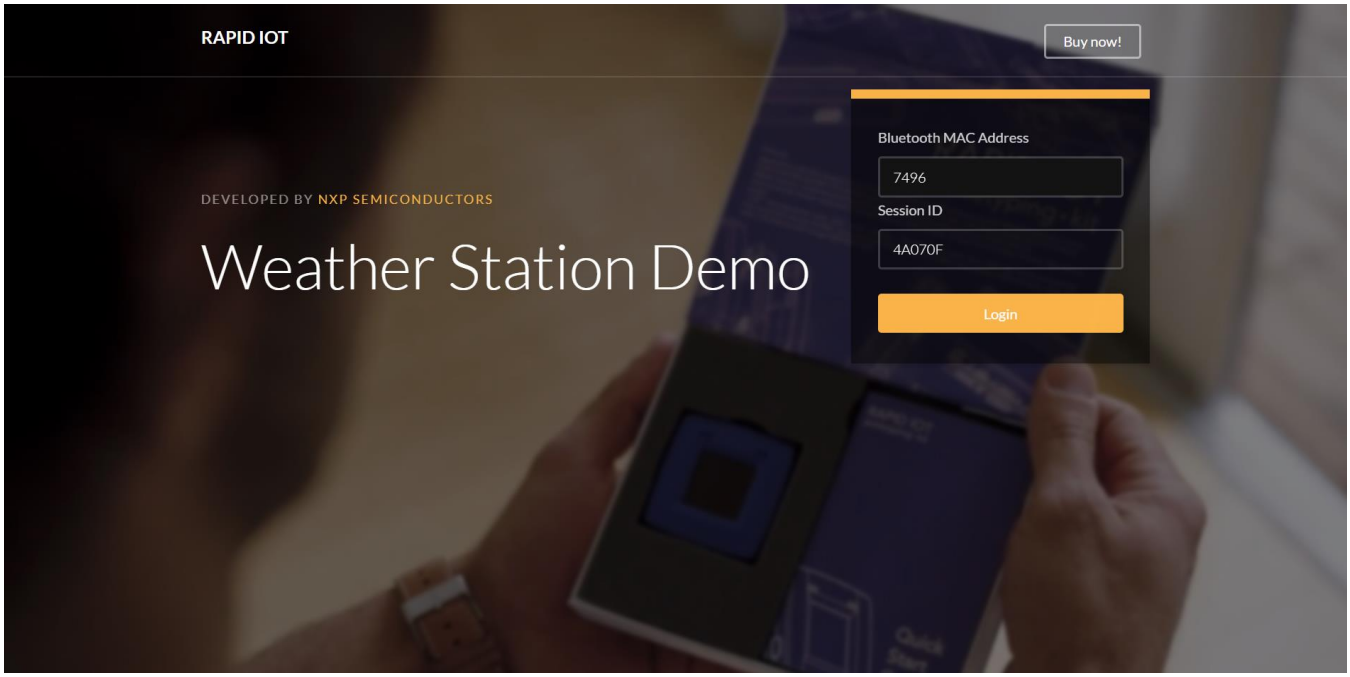

Figure 25. Login into the cloud application

Using the cloud application

When logged into the cloud application, the main page will appear and the graphs will show the measurements that have already being sent to the database. In case the user wants to see any particular point in the graph, it is just necessary to hover the mouse pointer on the desired measurement to read. See Figure 26.

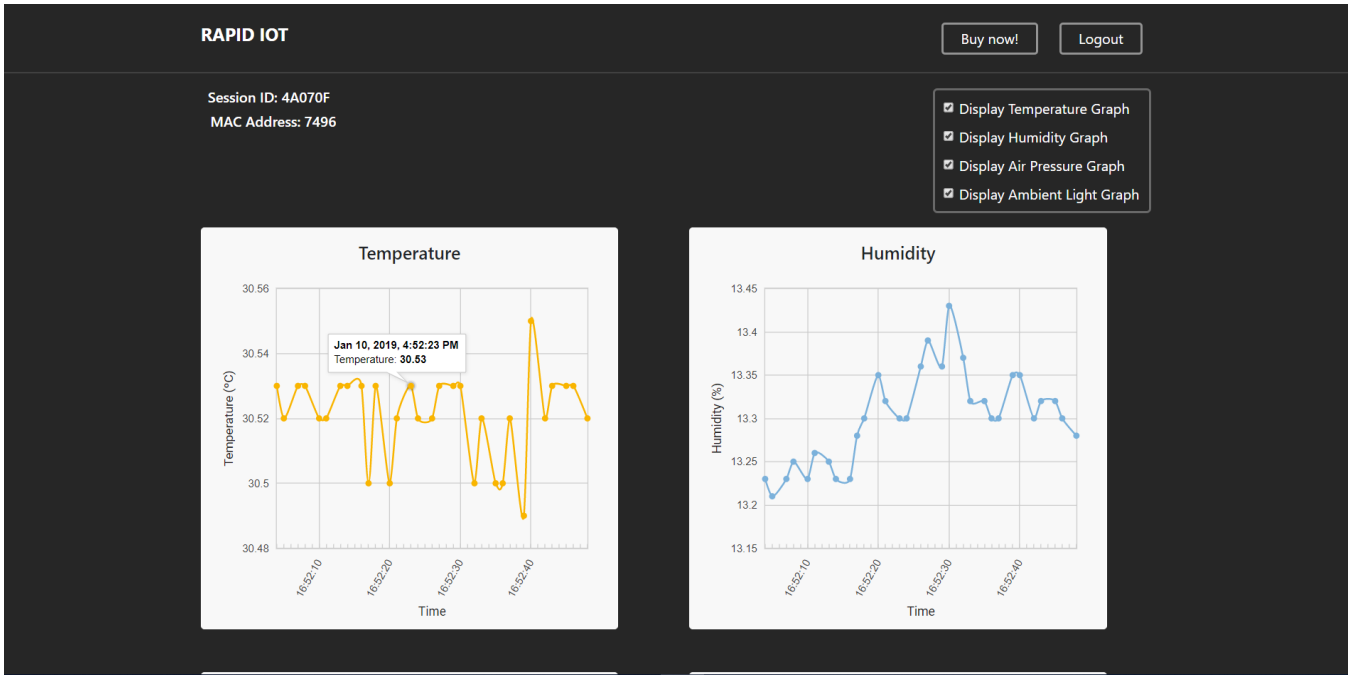

Figure 26. Reading measurement from a table

Apart from reading the data in the tables, it is also possible to export all the measurements belonging to that session ID. An example of an exported .csv file is shown in Figure 27.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Timestamp; Name; SessionID; MAC Address; Temperature; Humidity; Pressure; Light															
2	1547135395; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.21; 1015; 106.14															
3	1547135394; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.12; 1015; 106.14															
4	1547135392; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.16; 1015; 106.14															
5	1547135392; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.16; 1015; 106.14															
6	1547135391; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.18; 1015; 106.14															
7	1547135389; RPK-7496; 4A070F; 0060370000127496; 30.55; 13.18; 1014; 106.14															
8	1547135389; RPK-7496; 4A070F; 0060370000127496; 30.55; 13.17; 1015; 106.14															
9	1547135388; RPK-7496; 4A070F; 0060370000127496; 30.55; 13.17; 1015; 106.14															
10	1547135386; RPK-7496; 4A070F; 0060370000127496; 30.55; 13.19; 1015; 106.14															
11	1547135386; RPK-7496; 4A070F; 0060370000127496; 30.55; 13.12; 1015; 106.14															
12	1547135385; RPK-7496; 4A070F; 0060370000127496; 30.56; 13.12; 1015; 106.14															
13	1547135383; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.18; 1014; 106.14															
14	1547135383; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.16; 1015; 106.14															
15	1547135382; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.16; 1014; 106.14															
16	1547135380; RPK-7496; 4A070F; 0060370000127496; 30.56; 13.14; 1014; 106.14															
17	1547135380; RPK-7496; 4A070F; 0060370000127496; 30.56; 13.16; 1015; 106.14															
18	1547135379; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.16; 1015; 106.14															
19	1547135378; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.21; 1015; 106.14															
20	1547135378; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.21; 1015; 106.14															
21	1547135376; RPK-7496; 4A070F; 0060370000127496; 30.56; 13.21; 1015; 106.14															
22	1547135375; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.21; 1015; 106.14															
23	1547135375; RPK-7496; 4A070F; 0060370000127496; 30.53; 13.23; 1015; 106.14															

RapidIoT_4A070F

Figure 27. Exported measurements in .csv format

In Figure 28 some other configurations for the cloud application are shown.

Figure 28. Configurations of the cloud application

As implemented in the mobile applications, the temperature unit can be changed between Celsius and Fahrenheit degrees. When changed from one unit to another, it is necessary either to manually refresh the website or wait until the next auto-refresh cycle.

The same happens with the timescale. It can be changed between seconds and minutes; once it has been changed, the website needs to be refreshed to take effect.

By selecting the Auto-refresh checkbox, the graphs will be automatically refreshed every 15 seconds; otherwise, it is necessary to manually click on the ‘Refresh’ button.

Clear database

Each user has a limited space in the cloud application of 1 Mb to store measurements. In order to avoid exceeding this limit, it is a good practice to clear the database in the mobile application once finished with the current session. Otherwise the system will automatically delete the oldest measurements to store the new ones.

Figure 29 shows how to clear the database in the mobile app.

When the data from the database is closed, the data plotted in the graphs is cleaned. This can be seen in Figure 30.

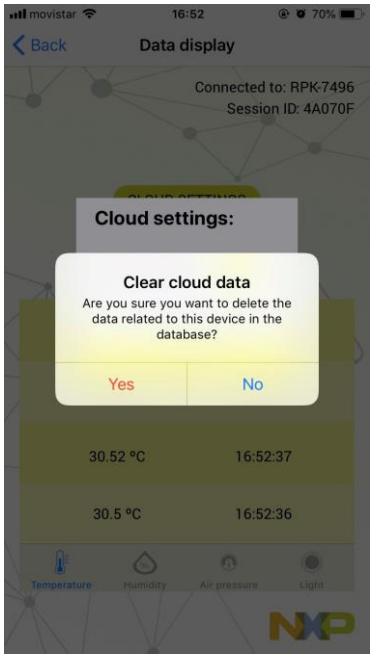

Figure 29. Clear database in mobile applications

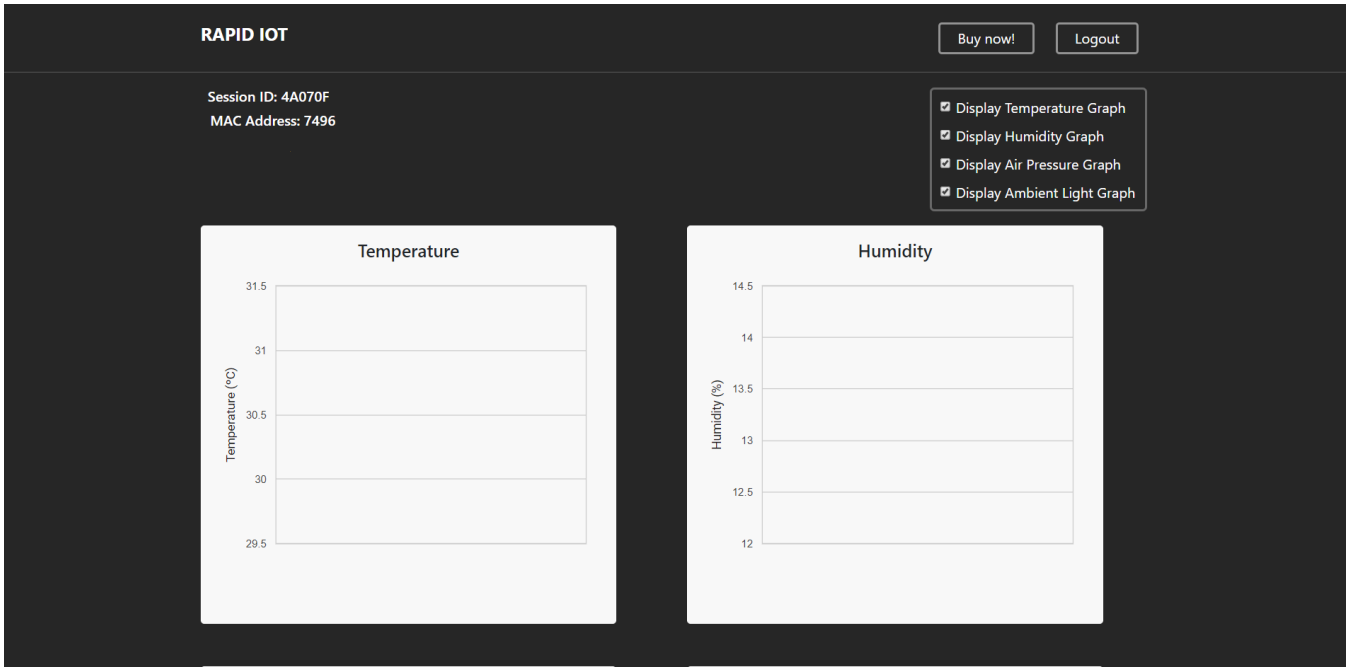

Figure 30. Cleared measurements in the cloud application

Close session and disconnect

Finally, to correctly close the current session, go to the main view of the mobile application. There are two options to disconnect from a device:

- Select another device in the table and connect to it.

- Long press the currently connected device and disconnect from it.

Figure 31 shows the current device marked as connected in the main menu. After a long press, we will disconnect from it and close the current session. This is shown in Figure 32.

Figure 31. Connected device marked in the main menu

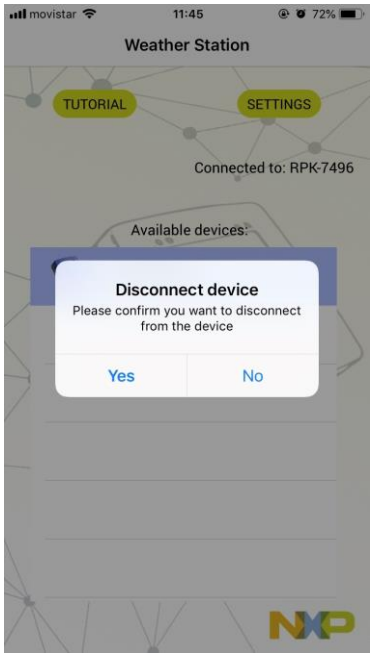

Figure 32. Disconnecting from a device

Revision history

Table 2. Sample revision history

Revision number	Date	Substantive changes
1.0	01/2019	Initial release

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