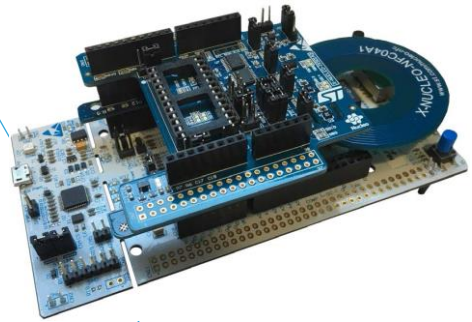
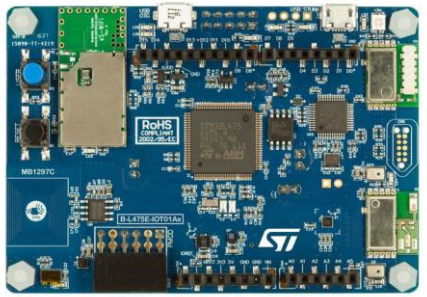
Quick Start Guide

STM32Cube function pack for IoT node with Wi-Fi, NFC and sensors for vibration analysis, connected to IBM Watson IoT cloud (FP-CLD-WATSON1)





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Version 2.4 (September 05, 2018)

Quick Start Guide Contents

FP-CLD-WATSON1: STM32Cube function pack for IoT node with Wi-Fi, NFC and sensors for vibration analysis, connected to IBM Watson IoT cloud

Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

Motion MEMS and environmental sensor expansion board (X-NUCLEO-IKS01A2)

Hardware overview (1/4)

X-NUCLEO-IKS01A2 Hardware description

- The X-NUCLEO-IKS01A2 is a motion MEMS and environmental sensor evaluation board system.
- It is compatible with the Arduino UNO R3 connector layout, and is designed around ST's latest sensors.

Key products on board

LSM6DSL

MEMS 3D accelerometer (±2/±4/±8/±16 g) + 3D gyroscope (±125/±245/±500/±1000/±2000 dps)

LSM303AGR

MEMS 3D magnetometer (±50 gauss) + MEMS 3D accelerometer (±2/±4/±8/±16 g)

LPS22HB

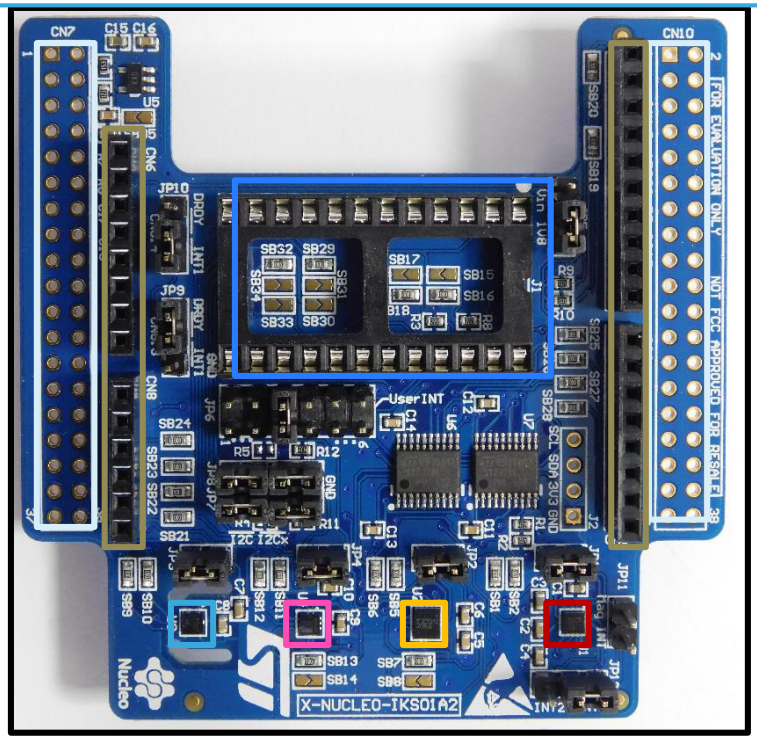
MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

HTS221

Capacitive digital relative humidity and temperature

DIL 24-pin

Socket available for additional MEMS adapters and other sensors (UV index)



HTS221 LSM6DSL ST morpho connector**

LPS22HB LSM303AGR Arduino UNO R3 connector

DIL 24-pin

Latest info available at www.st.com
X-NUCLEO-IKS01A2

** Connector for the STM32 Nucleo Board

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Dynamic NFC tag expansion board
Hardware Overview (2/4)

X-NUCLEO-NFC04A1 Hardware Description

- The X-NUCLEO-NFC04A1 dynamic NFC/RFID tag IC expansion board is based on the ST25DV04K NFC Type V/RFID tag IC with a dual interface 4 Kbits EEPROM that also features an I²C interface. It can be powered by the pin of Arduino connector or directly by the received carrier electromagnetic field.
- The X-NUCLEO-NFC04A1 expansion board is compatible with the Arduino™ UNO R3 connector pin assignment and can easily be plugged onto any STM32 Nucleo board. Various expansion boards can also be stacked to evaluate different devices operating together with the dynamic NFC tag. The board also features an antenna with a 54 mm ISO 24.2 diameter, single layer, copper etched on PCB.

Key products on board

ST25DV04KV
Dynamic NFC/RFID tag IC with 4-Kbit, 16-Kbit or 64-Kbit EEPROM, and Fast Transfer Mode capability

Latest info available at www.st.com
X-NUCLEO-NFC04A1

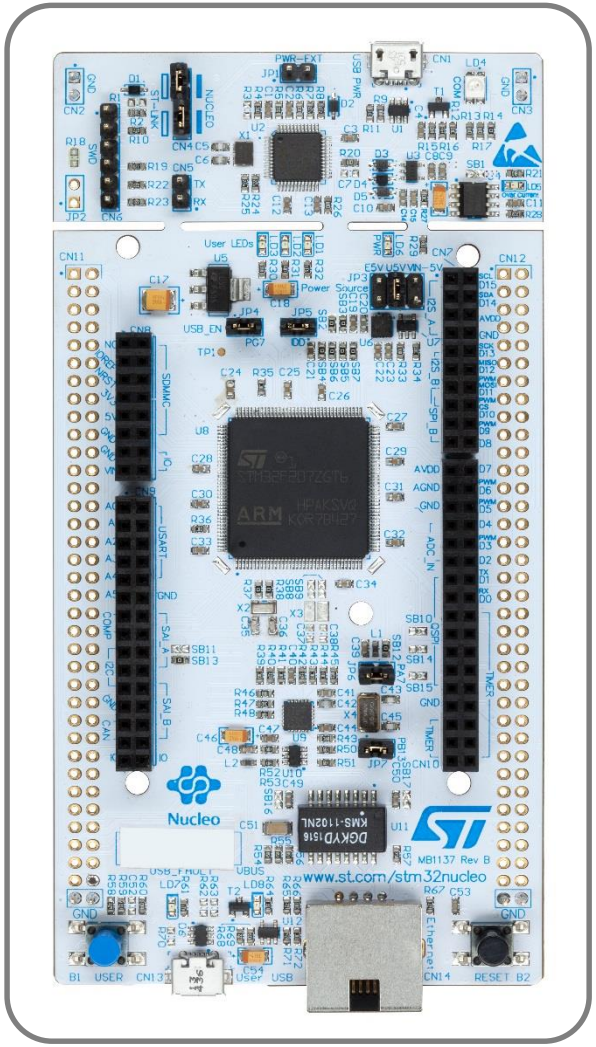
NUCLEO-F429ZI board
Hardware Overview (3/4)

NUCLEO-144 Hardware Description

The STM32 Nucleo-144 boards (NUCLEO-F207ZG, NUCLEO-F303ZE, NUCLEO-F412ZG, NUCLEO-F413ZH, NUCLEO-F429ZI, NUCLEO-F446ZE, NUCLEO-F722ZE, NUCLEOF746ZG, NUCLEO-F767ZI and NUCLEO-H743ZI) provide an affordable and flexible way for users to try out new concepts and build prototypes, by choosing from the various combinations of performance and power consumption features provided by the STM32 microcontroller.

Key Product on board

- 2 types of extension resources:
  - ST Zio connector including: support for Arduino™ Uno V3 connectivity (A0 to A5,D0 to D15) and additional signals exposing a wide range of peripherals
  - ST morpho extension pin header footprints for full access to all STM32 I/Os
- USB OTG or full-speed device with Micro-AB connector (depending on STM32 support)
- IEEE-802.3-2002 compliant Ethernet connector
- Flexible board power supply:
  - 5 V from ST-LINK/V2-1 USB VBUS
  - External power sources: 3.3 V and 7 - 12 V on ST Zio or ST morpho connectors, 5 V on ST morpho connector
- On-board ST-LINK/V2-1 debugger/programmer with SWD connector



Latest info available at www.st.com
NUCLEO-F429ZI

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STM32L4 Discovery Board for IoT node (B-L475E-IOT01A)

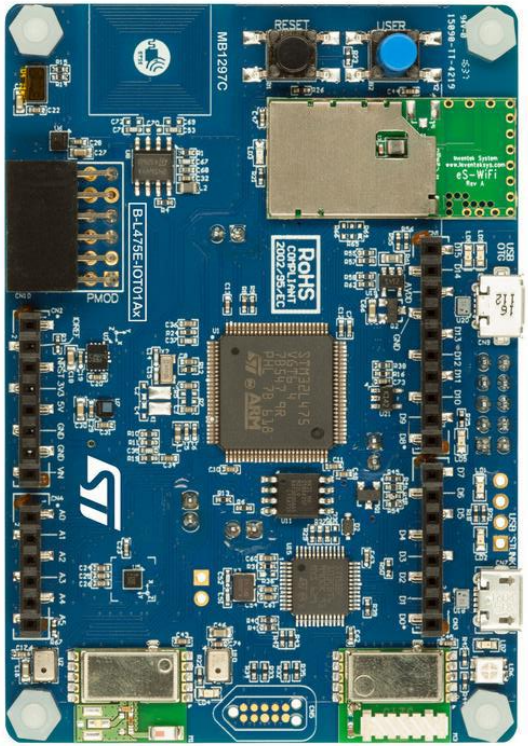
Hardware Overview (4/4)

STM32L4 Discovery Board for IoT node (B-L475E-IOT01A) Hardware Description

The STM32L4 Discovery kit for the IoT node (B-L475E-IOT01A) allows users to develop applications with direct connection to cloud servers. The STM32L4 Discovery kit enables a wide diversity of applications by exploiting low-power multilink communication (BLE, Sub- GHz), multiway sensing (detection, environmental awareness) and ARM® Cortex®-M4 core-based STM32L4 Series features. Arduino™ Uno V3 and PMOD connectivity provide unlimited expansion capabilities with a large choice of specialized add-on boards.

Key Product on board

- Ultra-low-power STM32L4 Series MCUs based on ARM® Cortex® -M4 core with 1 Mbyte of Flash memory and 128 Kbytes of SRAM, in LQFP100 package
- Bluetooth® V4.1 module (SPBTLE-RF)
- Sub-GHz (868 or 915 MHz) low-power-programmable RF module (SPSGRF-868 or SPSGRF-915)
- Wi-Fi® module Inventek ISM43362-M3G-L44 (802.11 b/g/n compliant)
- Dynamic NFC tag based on M24SR with its printed NFC antenna
- 2 digital omnidirectional microphones (MP34DT01)
- Capacitive digital sensor for relative humidity and temperature (HTS221)
- High-performance 3-axis magnetometer (LIS3MDL), 3D accelerometer and 3D gyroscope (LSM6DSL), 260-1260 hPa absolute digital output barometer (LPS22HB), Time-of-Flight and gesture-detection sensor (VL53L0X)
- USB OTG FS with Micro-AB connector
- Expansion connectors: Arduino™ Uno V3, PMOD
- Flexible power-supply options: ST LINK USB VBUS or external sources
- On-board ST-LINK/V2-1 debugger/programmer with USB re-enumeration capability: mass storage, virtual COM port and debug port



Latest info available at www.st.com
B-L475E-IOT01A

FP-CLD-WATSON1 Software Overview

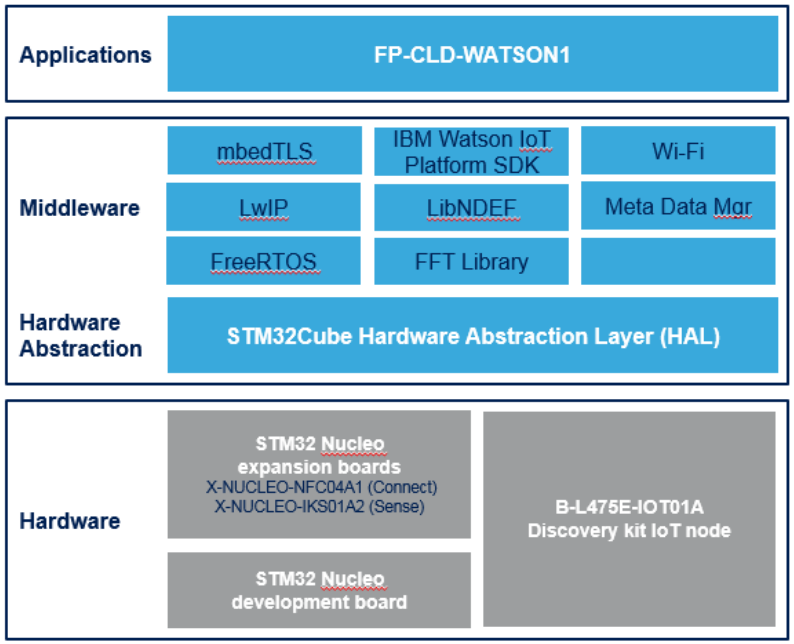
FP-CLD-WATSON1 Software Description

FP-CLD-WATSON1 is an STM32Cube function pack. It can connect an IoT node based on the STM32L4 Discovery kit IoT node (B-L475E-IOT01A) or theNUCLEOF429ZI to IBM Watson IoT, transmit sensor data and receive commands from remote applications. This package lets you jump-start end-to-end IoT development so that you can focus on adding desired functions..

Key features

- Complete middleware to build applications based on Wi-Fi/Ethernet connectivity, inertial and environmental sensors, and to connect an STM32 Nucleo-144 development board with STM32F429ZI MCU, or an STM32L4 Discovery kit IoT node (B-L475E-IOT01A) to IBM Watson IoT Cloud.
- Provide software interface to access temperature and humidity sensor (HTS221), pressure sensor (LPS25HB), motion sensors (LIS3MDL, LSM303AGR, LSM6DS0, LSM6DSL) and to write and read the RFID/NFC tag (ST25DV04K)
- Integrated mbedTLS and MQTT protocol middleware
- Integrated Fast Fourier Transform (FFT) algorithm for vibration analysis
- Sample implementation based on Wi-Fi connectivity available for STM32L4 Discovery kit IoT node (B-L475E-IOT01A), based on Ethernet connectivity available for X-NUCLEO-IKS01A2, and X-NUCLEO-NFC04A1, when both connected to a NUCLEO-F429ZI
- Easy access to IBM Watson IoT Cloud services for sensors data visualization and processing.

Overall Software Architecture



Latest SW available at www.st.com

FP-CLD-WATSON1

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Quick Start Guide Contents

FP-CLD-WATSON1: STM32Cube function pack for IoT node with Wi-Fi, NFC and sensors for vibration analysis, connected to IBM Watson IoT cloud

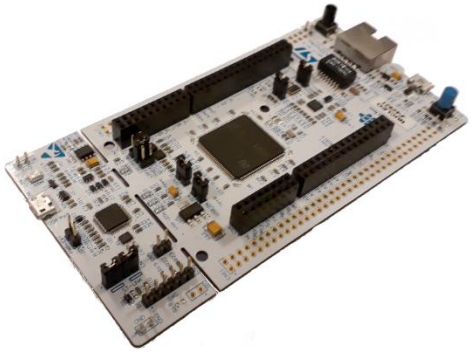
Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

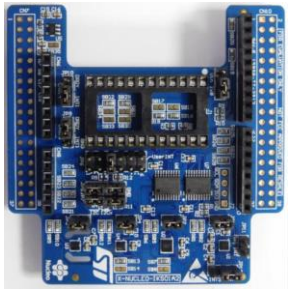
Setup & Demo Examples
HW prerequisites (1/2)

- 1x Motion MEMS and environmental sensor expansion board for STM32 Nucleo (**X-NUCLEO-IKS01A2**)
  - **Note**: the vibration analysis application is available only when using the X-NUCLEO-IKS01A2 board
- 1x Dynamic NFC tag expansion board expansion board for STM32 Nucleo (**X-NUCLEO-NFC04A1**) (optional)
- 1x STM32 Nucleo development board **(NUCLEO-F429ZI)**
- NFC-enabled Android™ device (optional)
- Windows 7 or higher - Laptop/PC
- Ethernet port for connectivity supporting DHCP
- 1 x micro USB cable



NUCLEO-F429ZI

Micro USB Cable



X-NUCLEO-IKS01A2

X-NUCLEO-NFC04A1 (optional)

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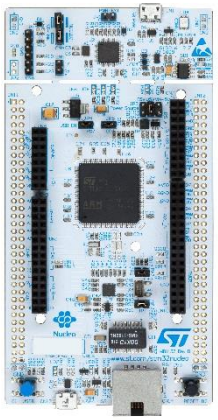
Setup & Application Examples

HW prerequisites for Nucleo and expansion board with Ethernet connectivity (2/2)

NUCLEO-F429ZI



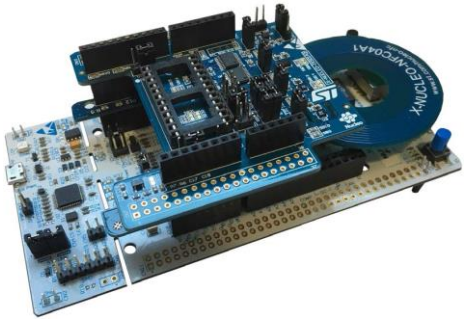
STM32 Nucleo-144

+

X-NUCLEO-IKS01A2

Sensors

+



Near Field Communication CERTIFIED

Dynamic NFC

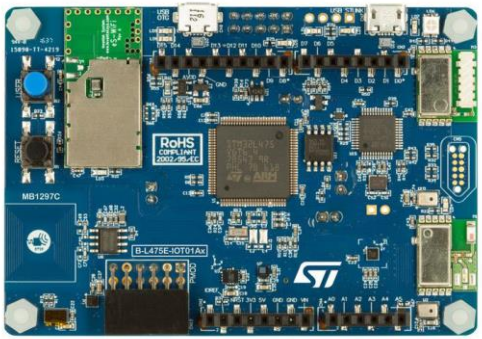
X-NUCLEO-NFC04A1

Setup & Application Examples (Azure_Sns_DM)

HW prerequisites for B-L475E-IOT01A

- 1x B-L475E-IOT01A development board
- NFC-enabled Android™ device (optional)
- Laptop/PC with Windows 7, 8 or 10
- 1 x microUSB cable
- Wi-Fi Router or access to a Wi-Fi network

MicroUSB Cable



B-L475E-IOT01A

SW prerequisites

- **STSW-LINK009**
  - ST-LINK/V2-1 USB driver
- **STSW-LINK007**:
  - ST-LINK/V2-1 firmware upgrade
- **FP-CLD-WATSON1**
  - Copy the .zip file content into a folder on your PC. The package will contain source code example (Keil, IAR, System Workbench) based only on NUCLEO-F429ZI
- **Serial line terminal** (e.g. TeraTerm, https://ttssh2.osdn.jp/)
- A mobile application for **Android/iOS** capable to read/write NFC tag (i.e. ST25 NFC https://play.google.com/store/apps/details?id=com.st.demo)

Wi-Fi, NFC and sensors software for Cloud connectivity

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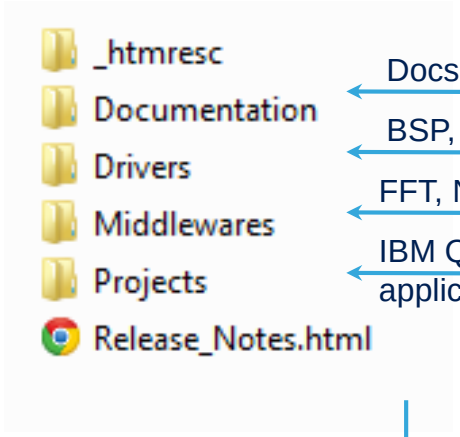
1 www.st.com/stm32ode-fp

2 Select Function Pack:
FP-CLD-WATSON1

3 Download & unpack

FP-CLD-WATSON1 package structure



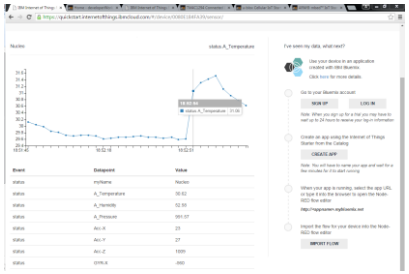
4 .\Projects\Multi\Applications\MQTT_IBM

KEIL Tools by ARM | IAR SYSTEMS | Open STM32 Tools

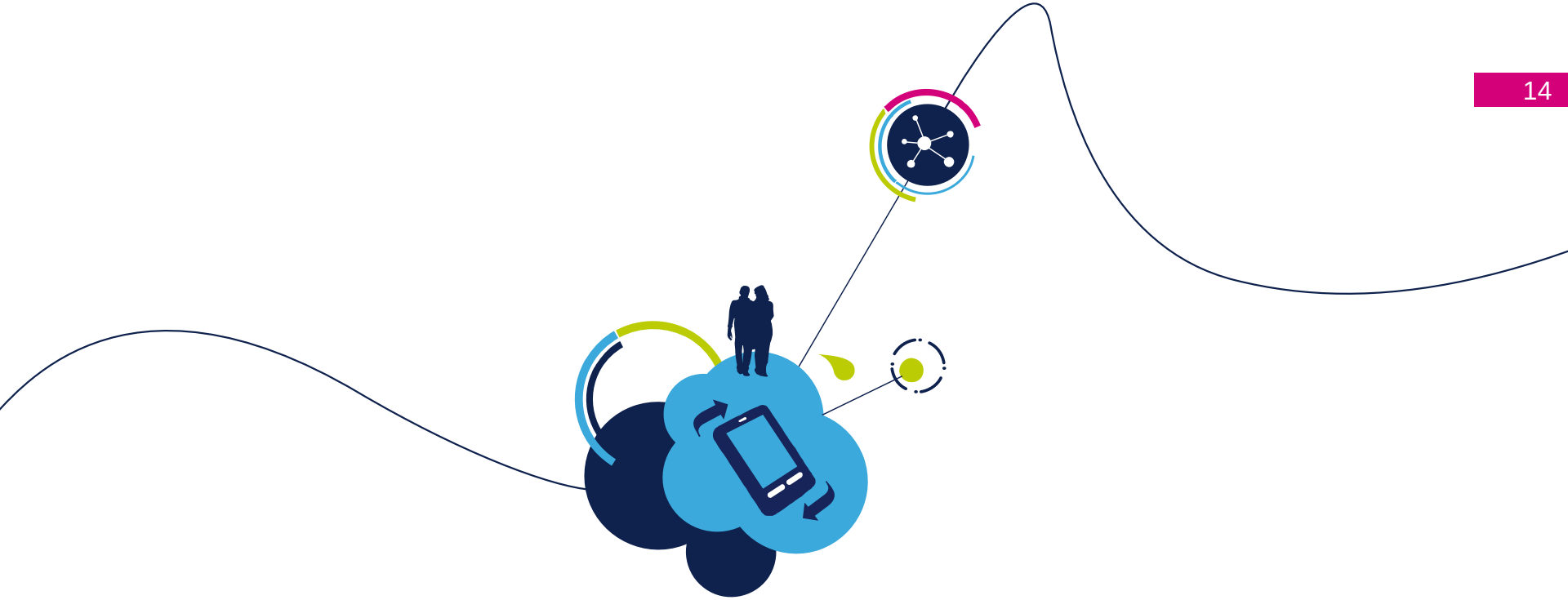
5 Compile/Flash and
Run the project

6 Visualize sensors data

Chrome
Web browser



NFC-enabled
smartphone



Quickstart mode configuration

Configure IBM Cloud Configuration Parameters via serial interface(1/2)

1. Configure a serial terminal with the following parameters to view log messages and write AP parameters. Tested with Teraterm version 4.96
   - BaudRate : 115200
   - Data : 8 bit
   - Parity : none
   - Stop : 1 bit
   - Flow Control : none
   - NewLine RX AUTO
   - NewLine TX : CR+LF
   - Local echo: Enabled

2. B-L475E-IOT01A requires Wi-Fi connectivity, provide Wi-Fi Credentials using terminal. This step is not needed for Nucleo-F429ZI based configuration:

```
*** WIFI connection ***

Push the User button (Blue) within the next 5 seconds if you want to update the
WiFi network configuration.

Your WiFi [redacted] need to be entered to proceed.

Enter SSID: nono
You have entered nono as the ssid.


Enter Security Mode (0 - Open, 1 - WEP, 2 - WPA, 3 - WPA2):3
You have entered [redacted] security mode.

Enter password: 12345678

Initializing the WiFi module
Module initialized successfully: Inventek eS-WiFi ISM43362-M3G-L44-SPI C3.5.2.3.
BETA9
Retrieving the WiFi module MAC address: c4:7f:51:03:8a:16
```

Configure IBM Cloud Configuration Parameters via serial interface(1/2)

3. Configure a serial terminal with the following parameters to view log messages and write AP parameters. Tested with Teraterm version 4.96
   - BaudRate : 115200
   - Data : 8 bit
   - Parity : none
   - Stop : 1 bit
   - Flow Control : none
   - NewLine RX AUTO
   - NewLine TX : CR+LF
   - Local echo: Enabled

4. Press RESET (Black) button on STM32 Nucleo to trigger initialization phase. Enter the root CA when firmware asks for it:
   - (copy-paste from Projects\Common\Bluemix\comodo_bluemix.pem):

```
*** Board personalization ***

*** Ethernet connection ***
Initializing LwIP on Ethernet interface

Starting DHCP client to get IP address...
IPaddress = 192.168.0.4
Mac address: 3e:1d:6d:aa:fc:0a
Retrieving the IP address.
IP address: 192.168.0.4

Updating TLS security credentials.

Enter the x509 certificates or keys as per the following format:
-----BEGIN CERTIFICATE-----
YMPGn8u67GB9t+aEMr5P+1gmIgNb1LTV+/Xjli5wwOQuvfwu7uJBVcA0Ln0kcmnL
R7EUQIN9Z/SG9jGr8XmksrUuEvmEF/Bibyc+E1ixVA0hmnM3oTDPb5Lc9un8rNsu
.......
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
YMPGn8u67GB9t+aEMr5P+1gmIgNb1LTV+/Xjli5wwOQuvfwu7uJBVcA0Ln0kcmnL
.......
-----END CERTIFICATE-----
\n.......

Enter your root CA:
```

Configure IBM Cloud Configuration Parameters via serial interface(2/2)

3. Enter Registration mode.

```
Enter Registration Mode (1 - Quickstart, 2 - Simple):
1
```

4. Enter Bluemix Configuration String.

```
Enter the Bluemix connection string of your device: (template: DeviceType=xxx;D
eviceId=xxx)
DeviceType=device_type;DeviceId=id1
```

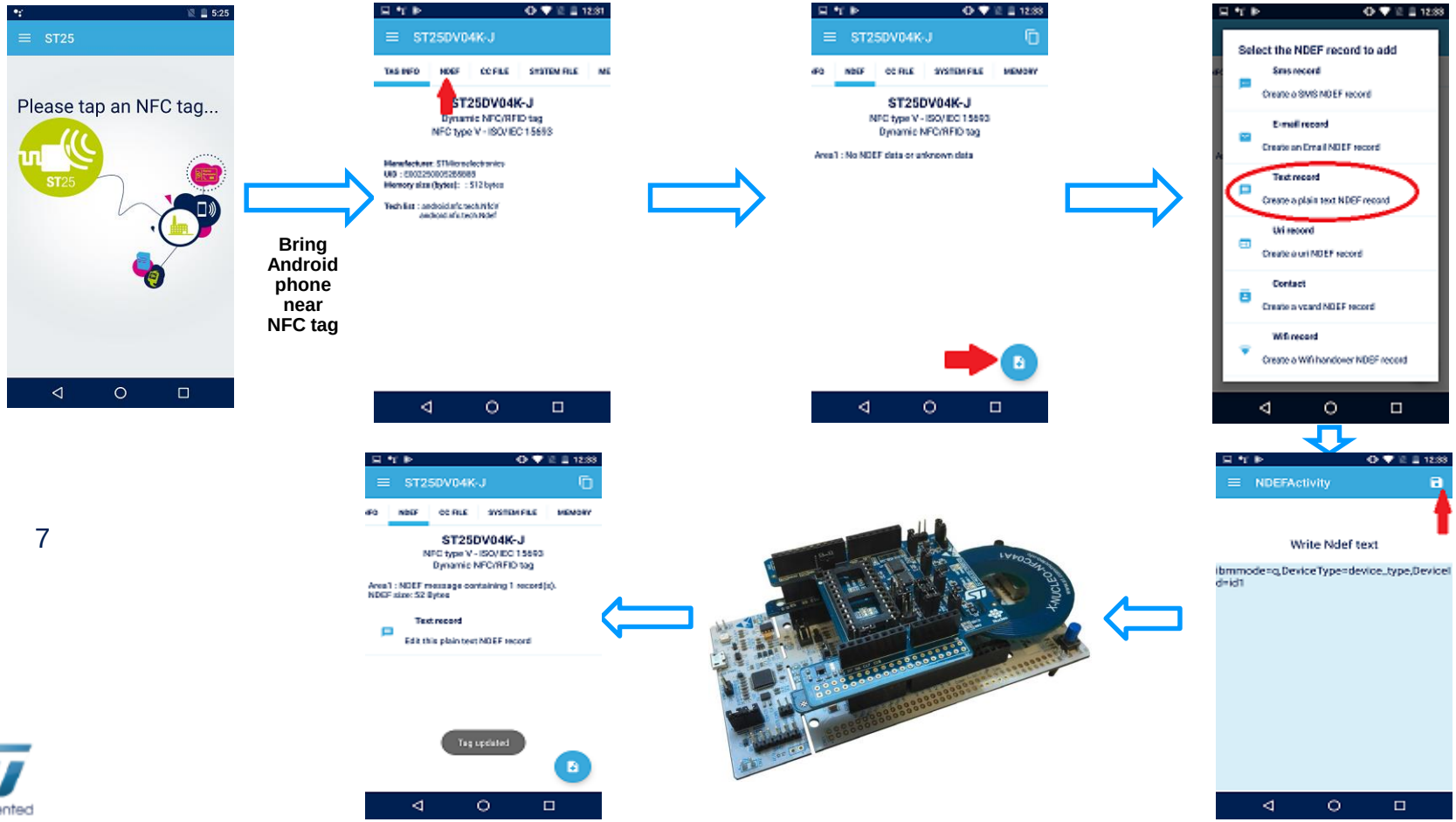
5. Device will start streaming sensor data to IBM Watson IoT platform service.

```
Setting the RTC from the network time.
Configuring the RTC from Date: Wed, 13 Jun 2018 06:56:21 GMT
fft library initialized
Device Client Connected to quickstart.messaging.internetofthings.ibmcloud.com P
latform in QuickStart Mode

You can see your published data at https://quickstart.internetofthings.ibmcloud
.com
Device Id is id1

When user button is pushed shortly, application publishes the sensor values, a
0/1 toggle value (the green Led switches accordingly) and a timestamp
On double button push, application enters in a loop and publishes automatically
 every second. Next double push returns to previous mode

FFTmaxAmpl: 969, FFTMaxFreq: 0
PayloadBuffer: {"d":{"temperature": 30.50, "humidity": 56.10, "pressure": 970.9
1, "acc_x": 0, "acc_y": 0, "acc_z": 979, "Motor_status": "OK", "FFTMaxFreqAmp":
 969, "FFTMaxFreq": 0 }}
publishing sensor data
FFTmaxAmpl: 969, FFTMaxFreq: 0
PayloadBuffer: {"d":{"temperature": 30.50, "humidity": 56.20, "pressure": 970.9
8, "acc_x": 0, "acc_y": 0, "acc_z": 948, "Motor_status": "OK", "FFTMaxFreqAmp":
 969, "FFTMaxFreq": 0 }}
publishing sensor data
```

Provision of device credentials using NFC (optional)(1/2)

This feature is only available for NUCLEO-F429ZI based configuration. NFC Usage for device credential provisioning is optional. And it requires usage of the X-NUCLEO-NFC04A1 expansion board.

1. Write Bluemix Configuration parameters to X-NUCLEO-NFC04A1 using a mobile application. E.g. with ST25 NFC mobile application for Android devices:



2. 7

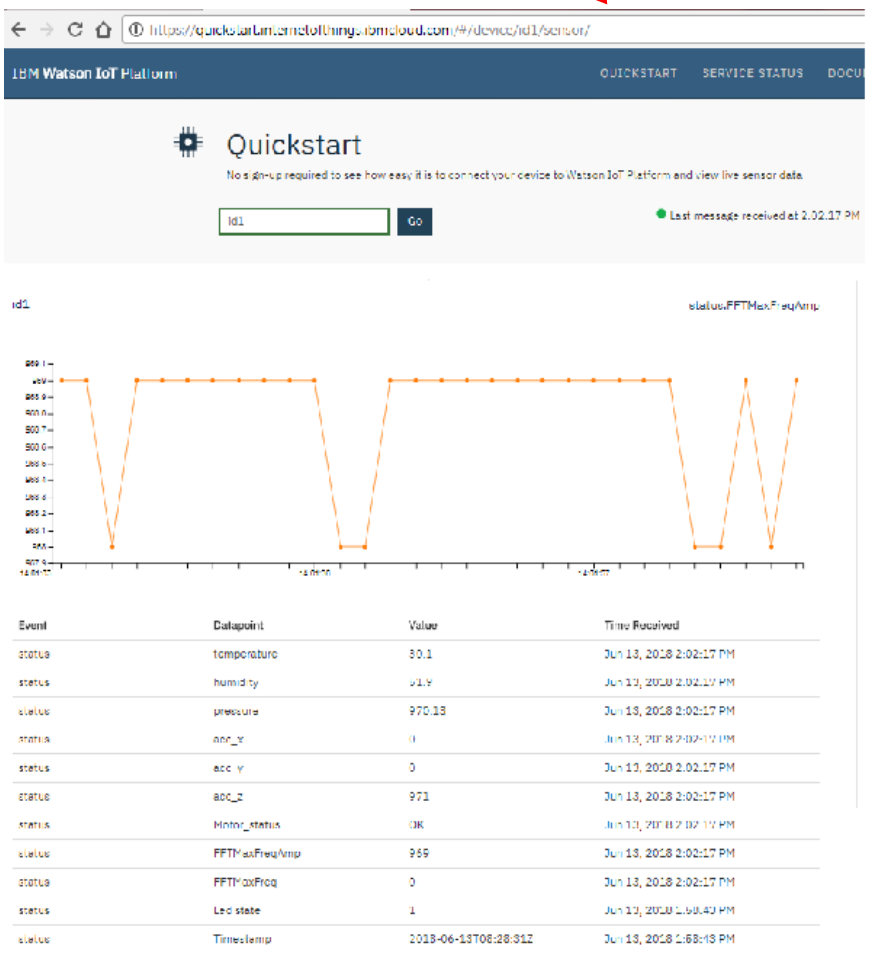
Provision of device credentials using NFC (optional) (2/2)

2. Format of configuration string passed in step #5 above:
   - ibmmode=q;DeviceType=your_device_type;DeviceId=id1

Quickstart URL to visualize sensors data

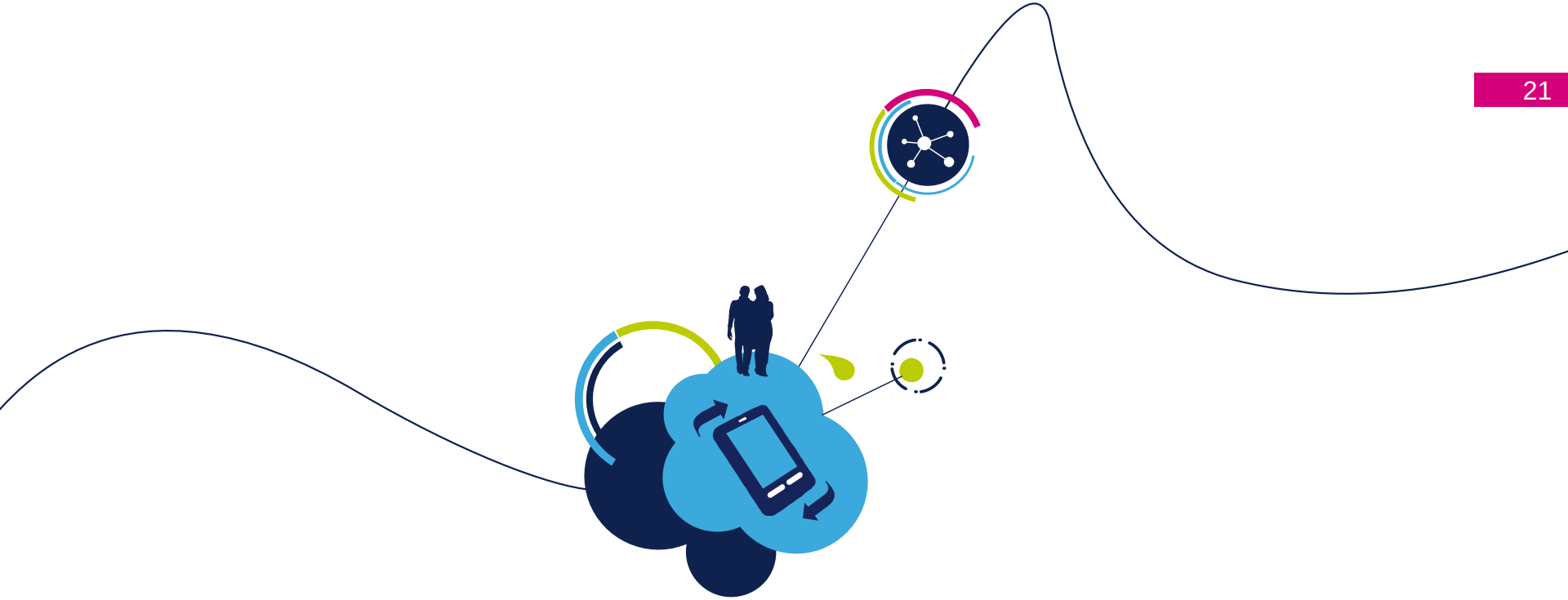
- Paste Quickstart URL in Chrome web browser

Paste the URL in the web browser



One set of sensors data are visualized at a time, selected from the list below i.e. FFT_max_f

List of sensors Data received



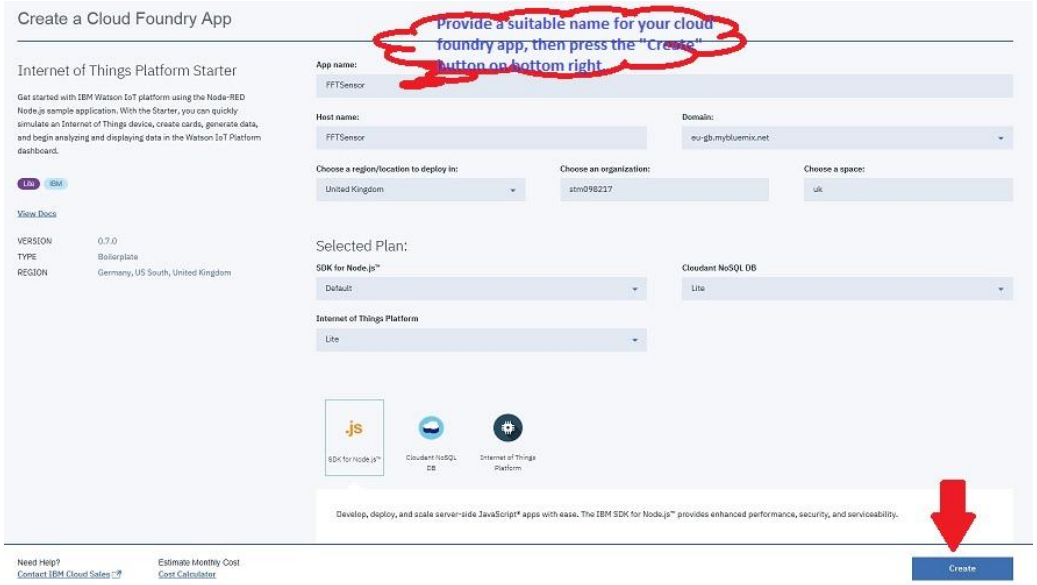
Registered mode configuration
Create dashboard in IBM Cloud

FP-CLD-WATSON1: Registered mode
Create Watson IoT Platform IBM Cloud

- “Registered mode” enables to connect your **STM32 Nucleo and expansion boards** to **IBM Cloud** and build scalable IoT applications based IBM Watson IoT platform

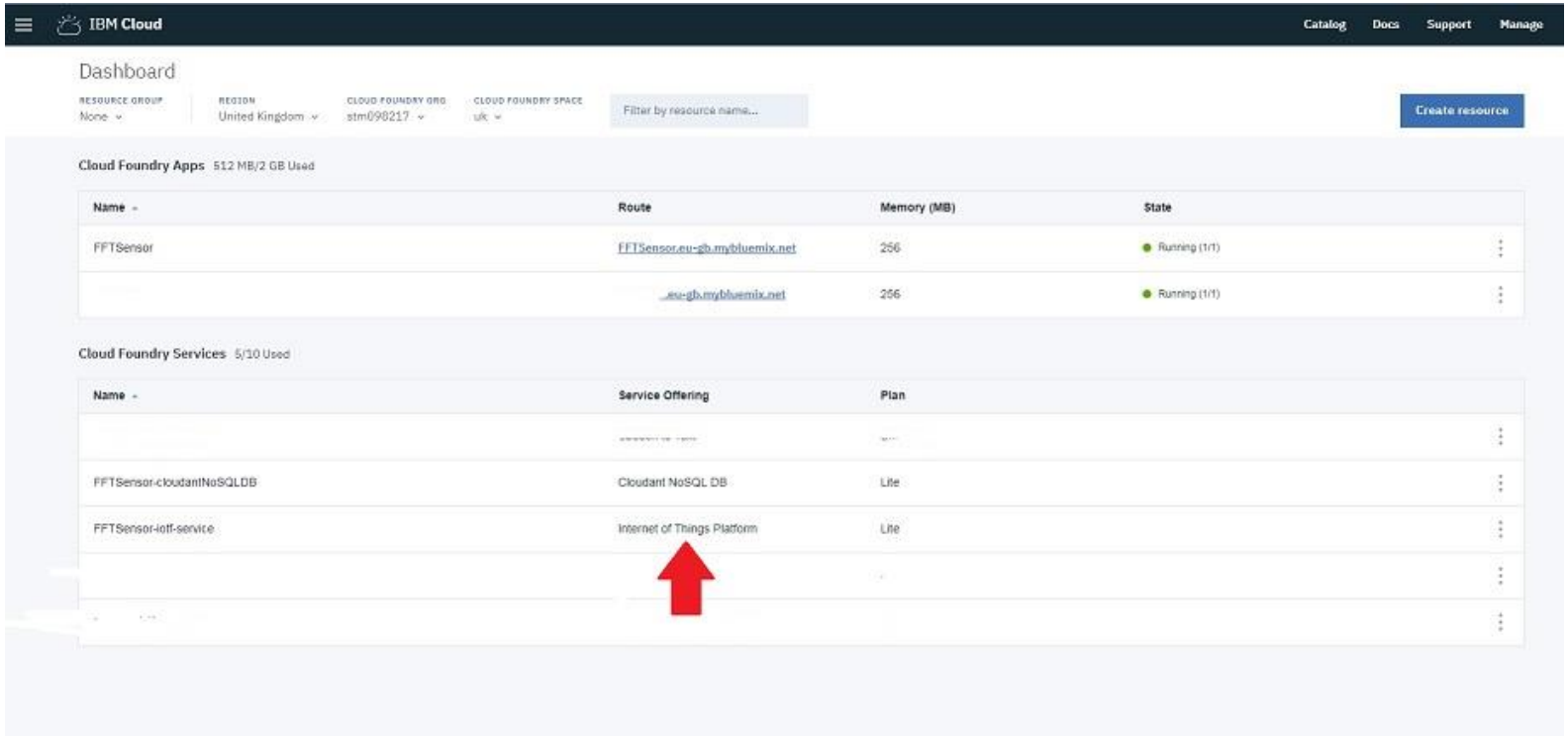
- Create a free account at IBM cloud by following instructions at https://console.bluemix.net/registration/

- Once you have an IBM cloud user account, use your credentials to create ***Internet of Things Platform Starter*** cloud foundry app



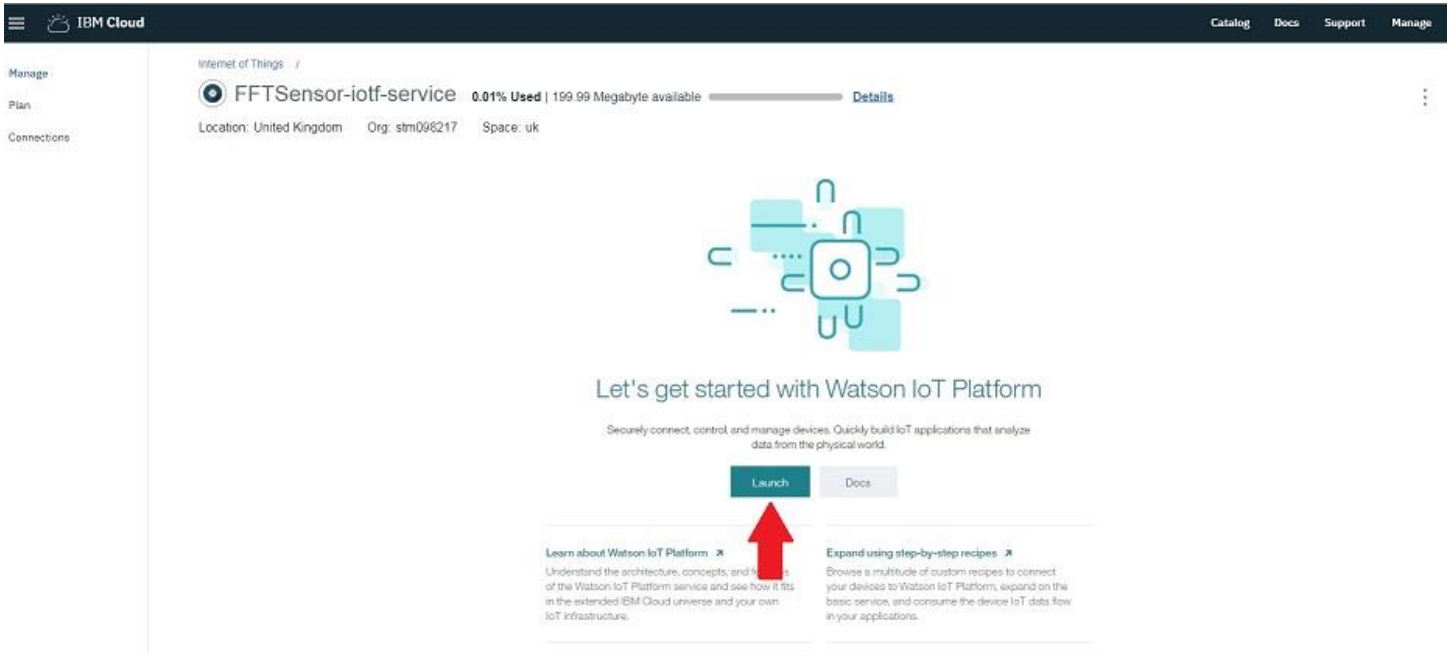
FP-CLD-WATSON1: Registered mode
Launch Watson IoT Platform (1/2)

- Click on the ***xxxx-iotf-service*** link in your IBM cloud dashboard



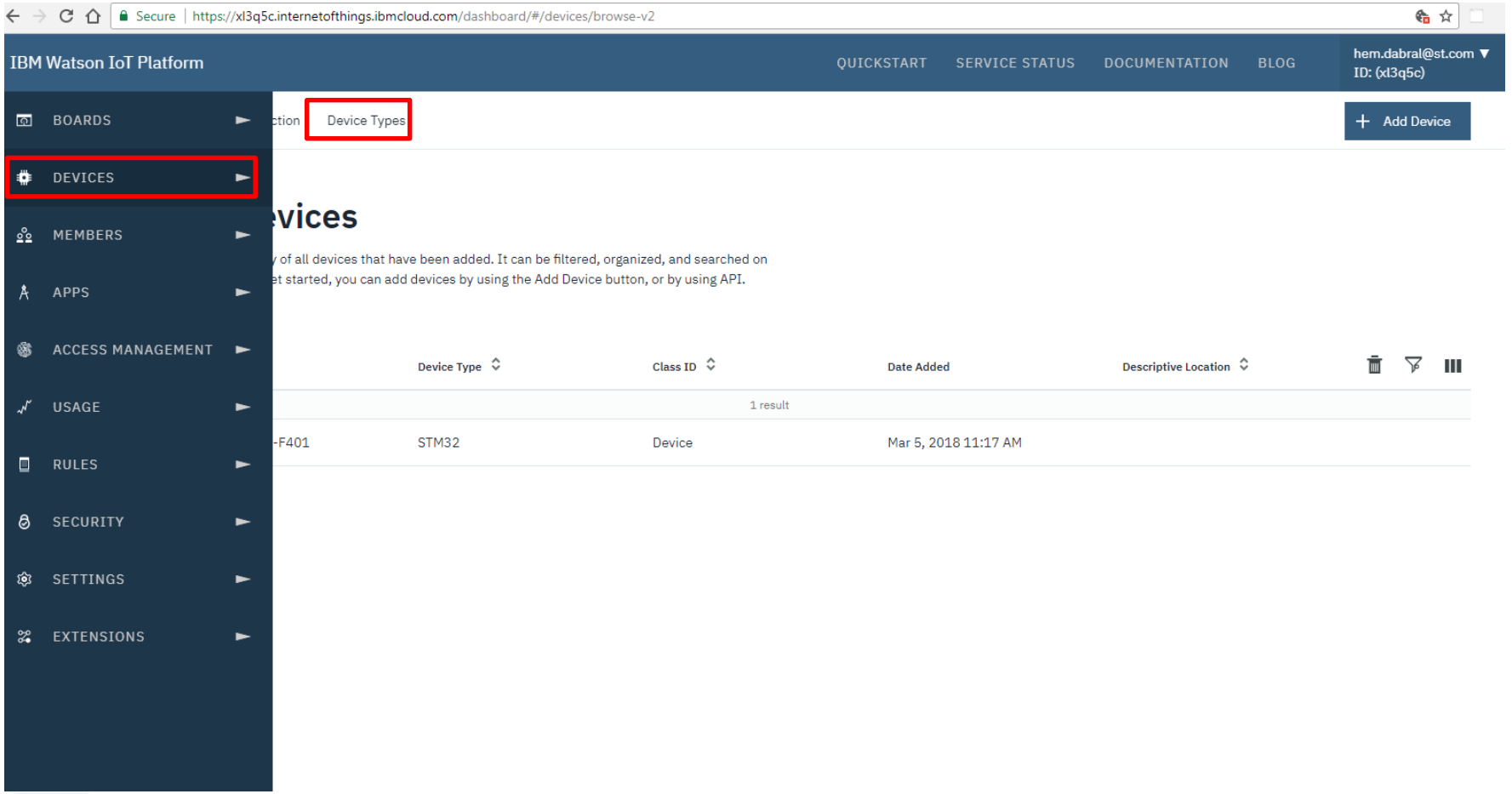
FP-CLD-WATSON1: Registered mode
Launch Watson IoT Platform (2/2)

- Click on **Launch** to open IBM Watson IoT platform service



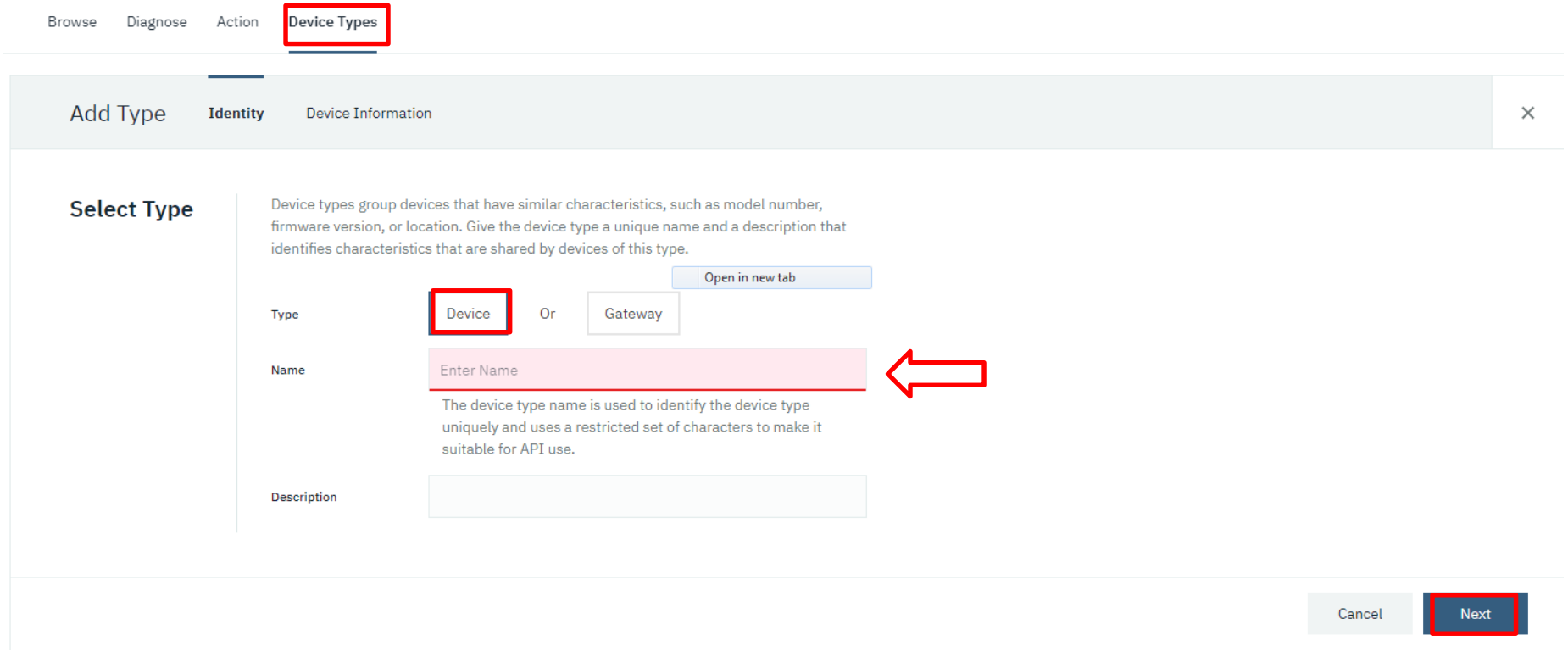
FP-CLD-WATSON1: Registered mode
Create a device type (1/2)

- Click on **Device** then **Device Types**



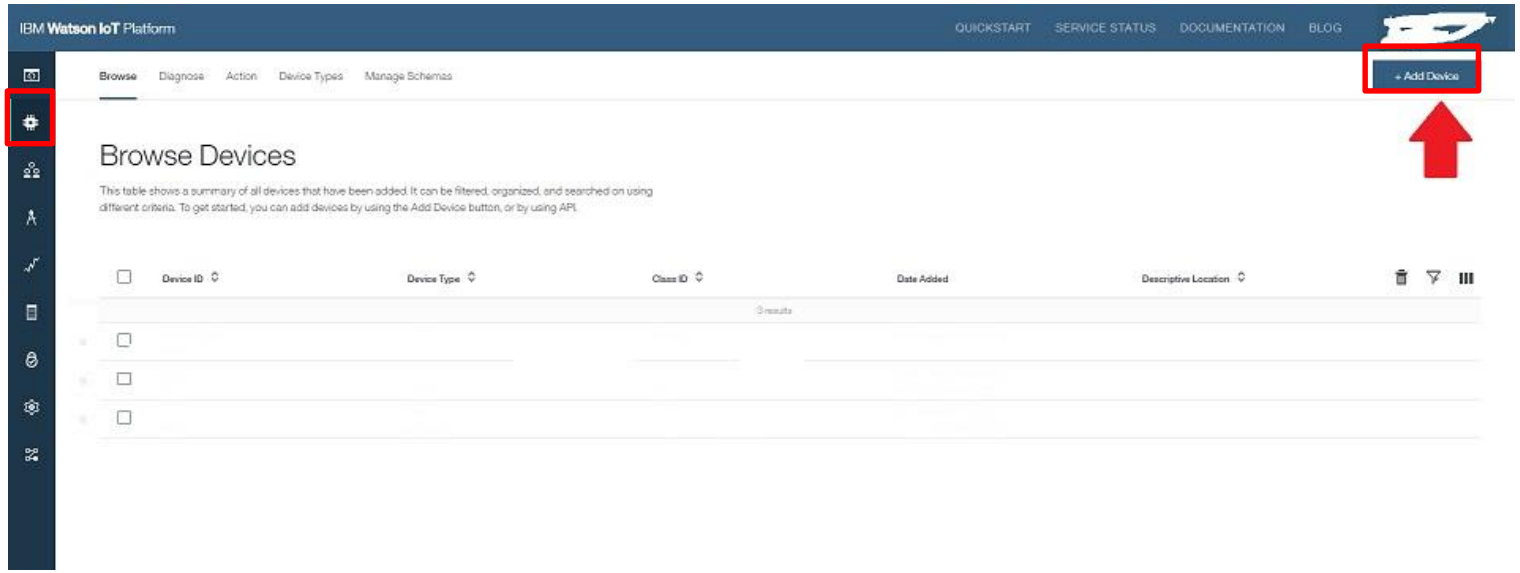
FP-CLD-WATSON1: Registered mode
Create a device type (2/2)

- Select Device as Device Type, enter **Device Type** name then click on **Next**



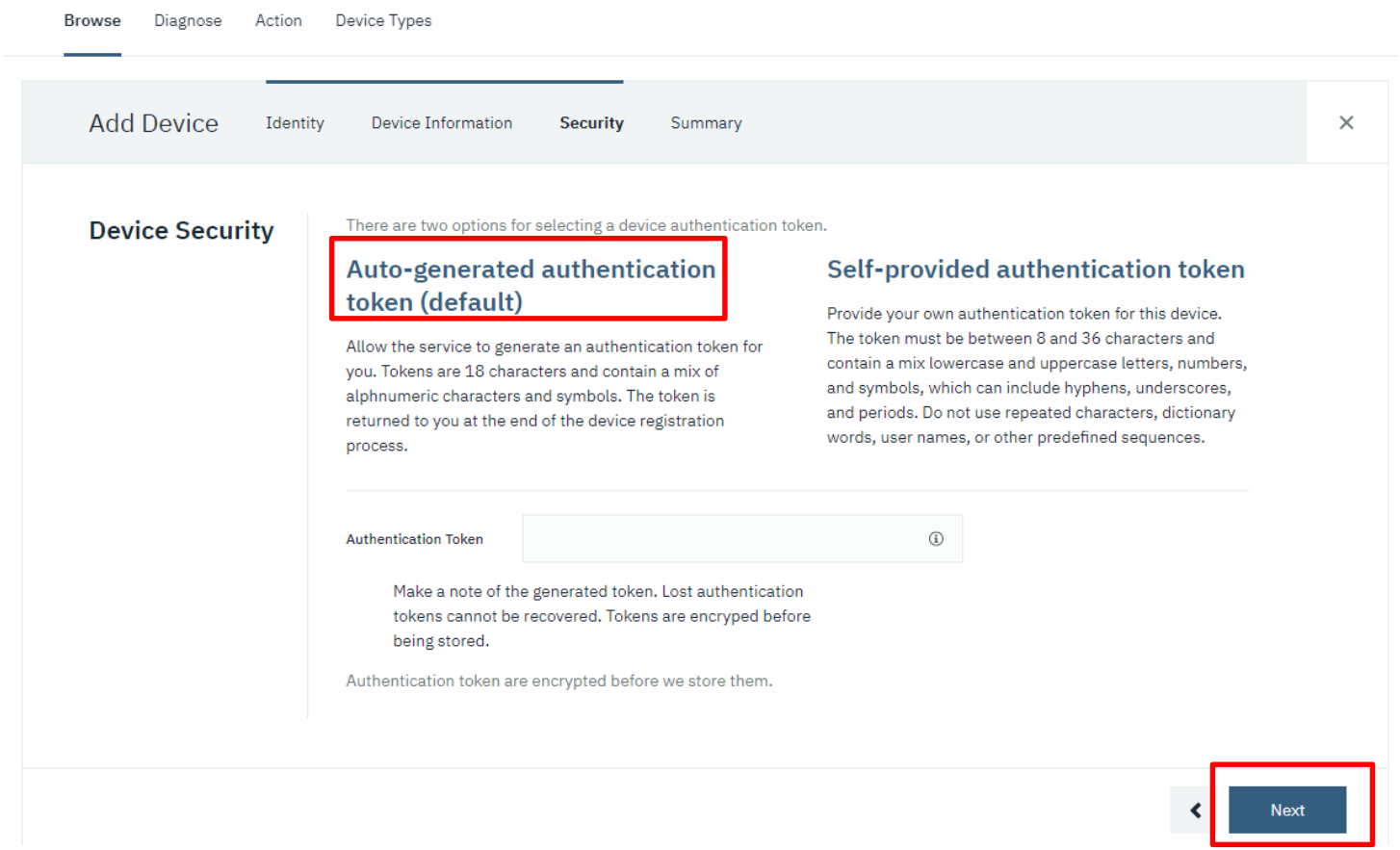
FP-CLD-WATSON1: Registered mode
Add a device (1/4)

- Select BroweDevices in left side bar, then add your device by clicking on **Add Device**
  - Please note that you might have to create a device type first



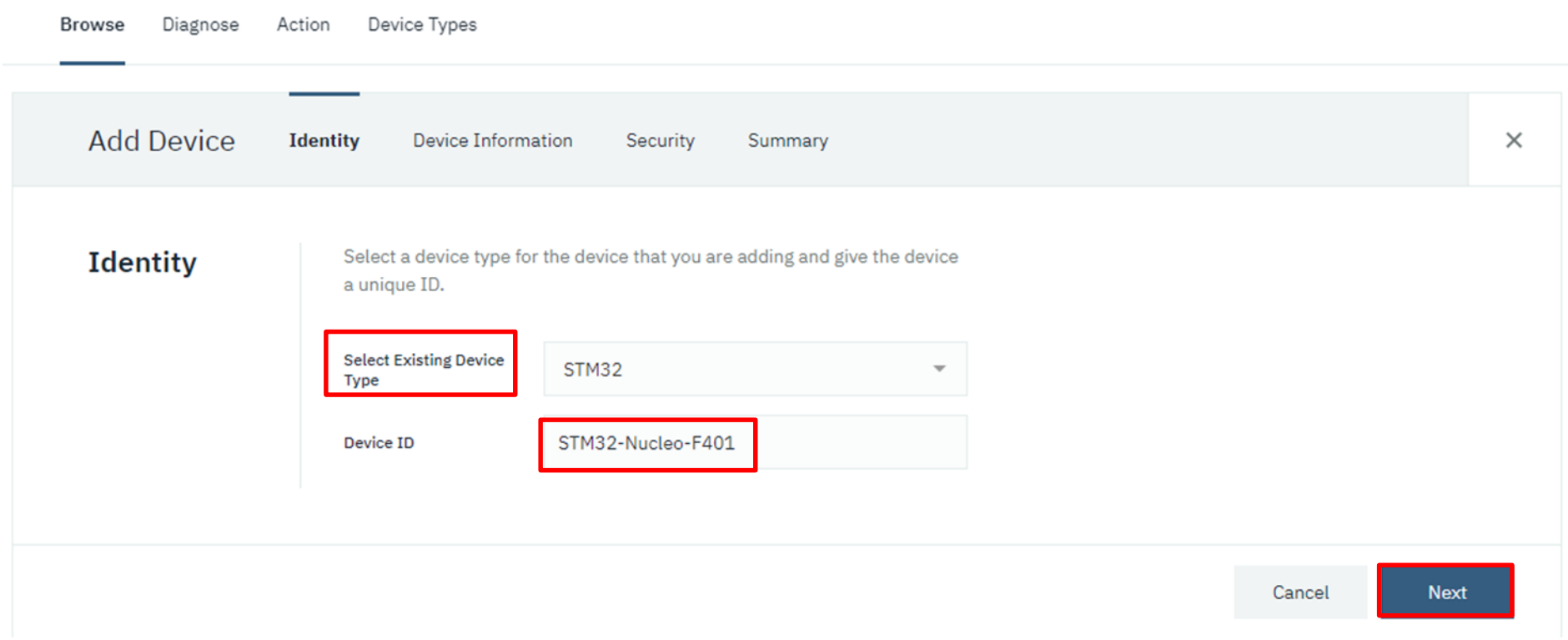
FP-CLD-WATSON1: Registered mode
Add a device (2/4)

- Select Auto-generated authentication token, then click on **Next**



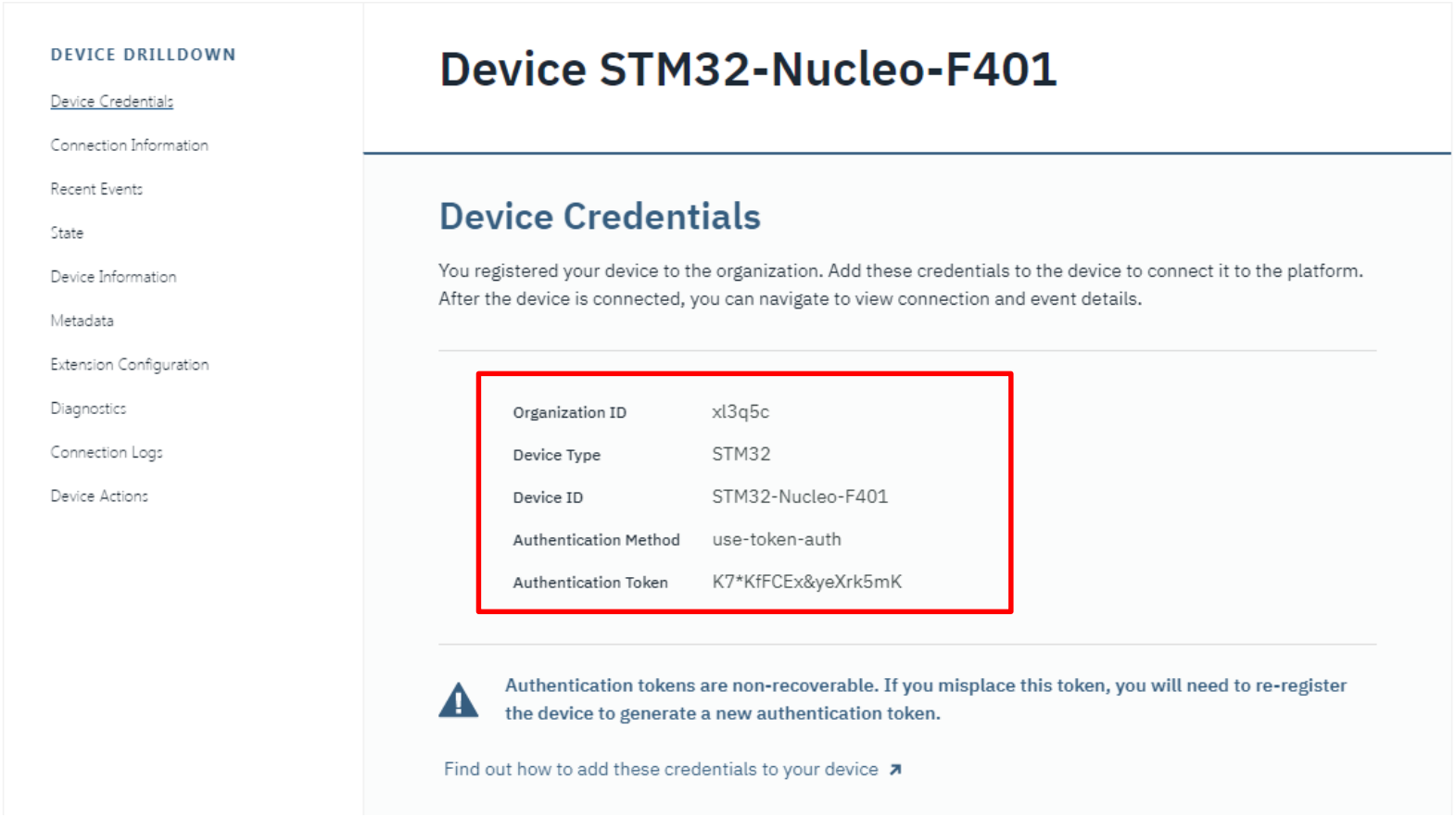
FP-CLD-WATSON1: Registered mode
Add a device (3/4)

- Select Device Type, enter your Device ID, then click on **Next**



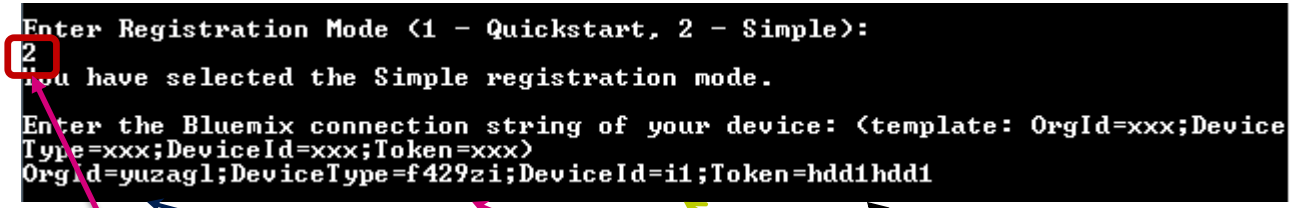
FP-CLD-WATSON1: Simple Registration mode
Add a device (4/4)

- Take note of device credentials generated for your device

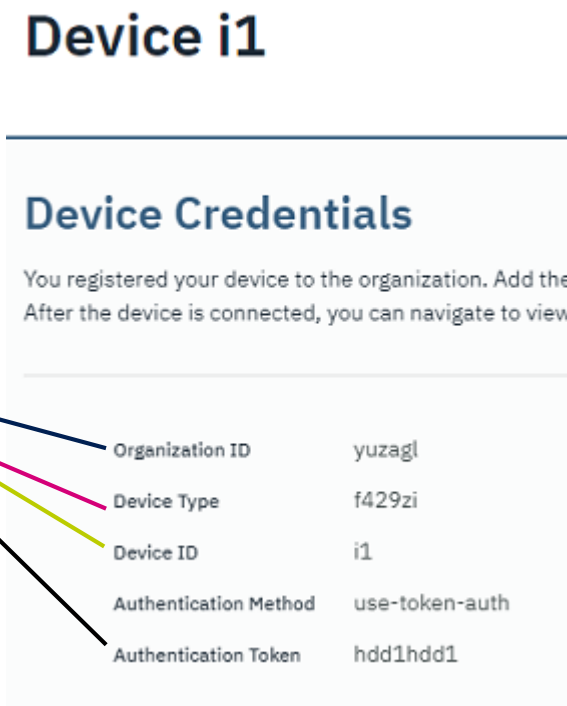


FP-CLD-WATSON1: Simple Registration mode
Provision credentials to STM32 Nucleo

- Reboot the STM32 Nucleo board. When requested select Registered mode. Enter device credentials as shown below



Simple Registeration Mode = 2



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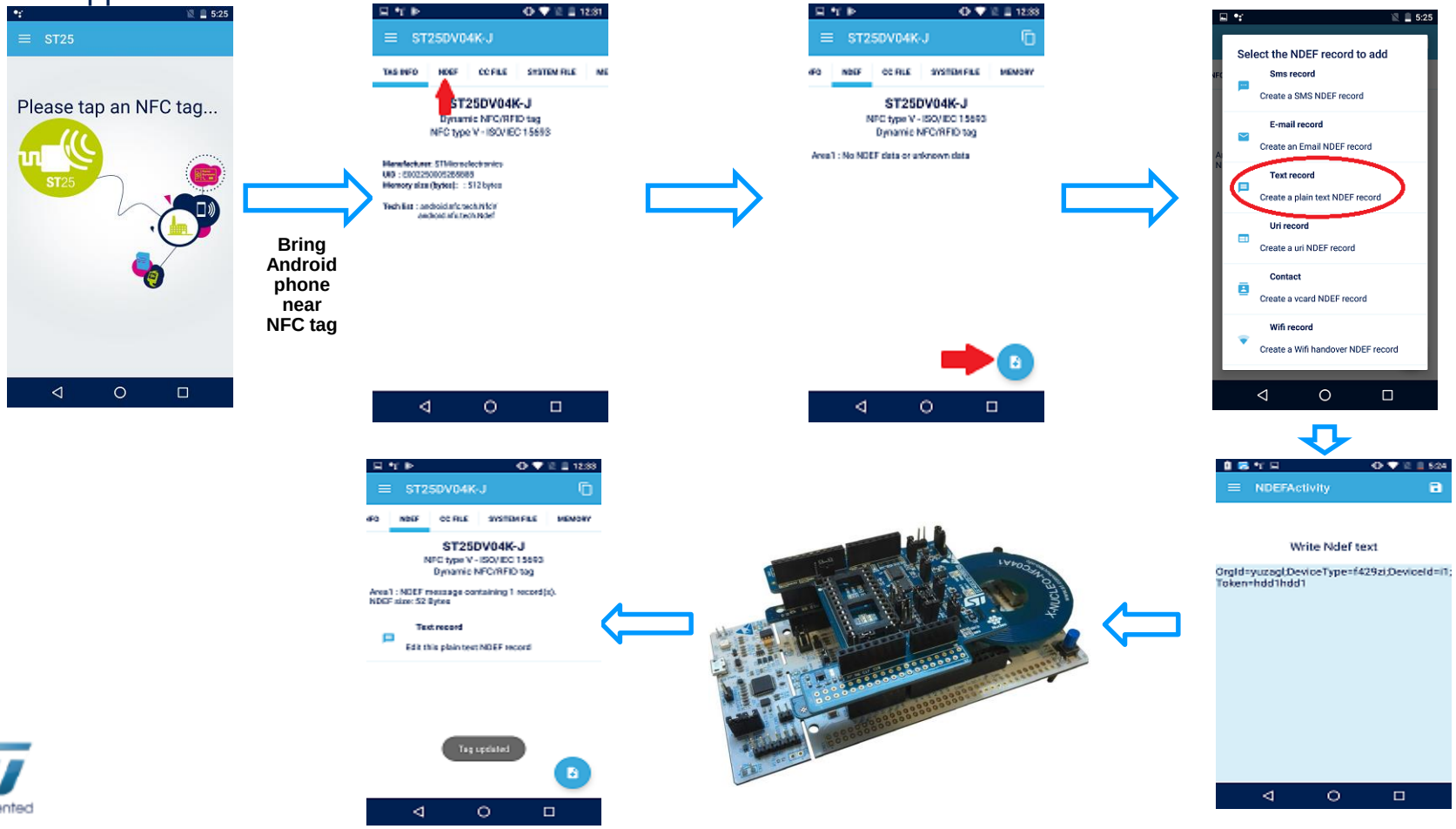
Provision of device credentials using NFC (optional)(1/2)

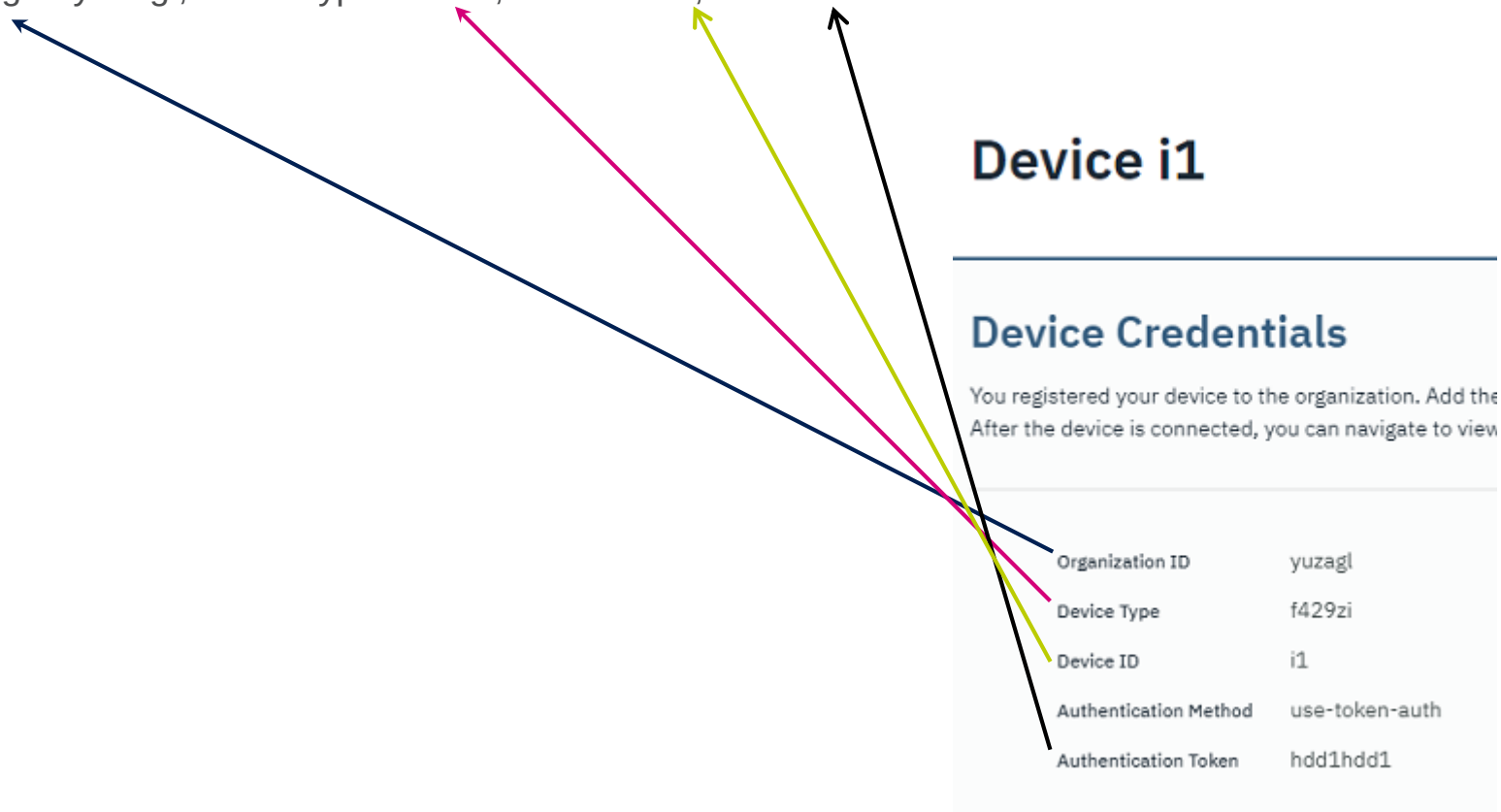
This feature is only available for Nucoe-F429ZI based configuration. NFC Usage for device credential provisioning is optional. And it requires usage of X-NUCLEO-NFC04A1 expansion board.

- Device credentials can also be written to device via NFC by using a mobile application. E.g. with ST25 NFC app:



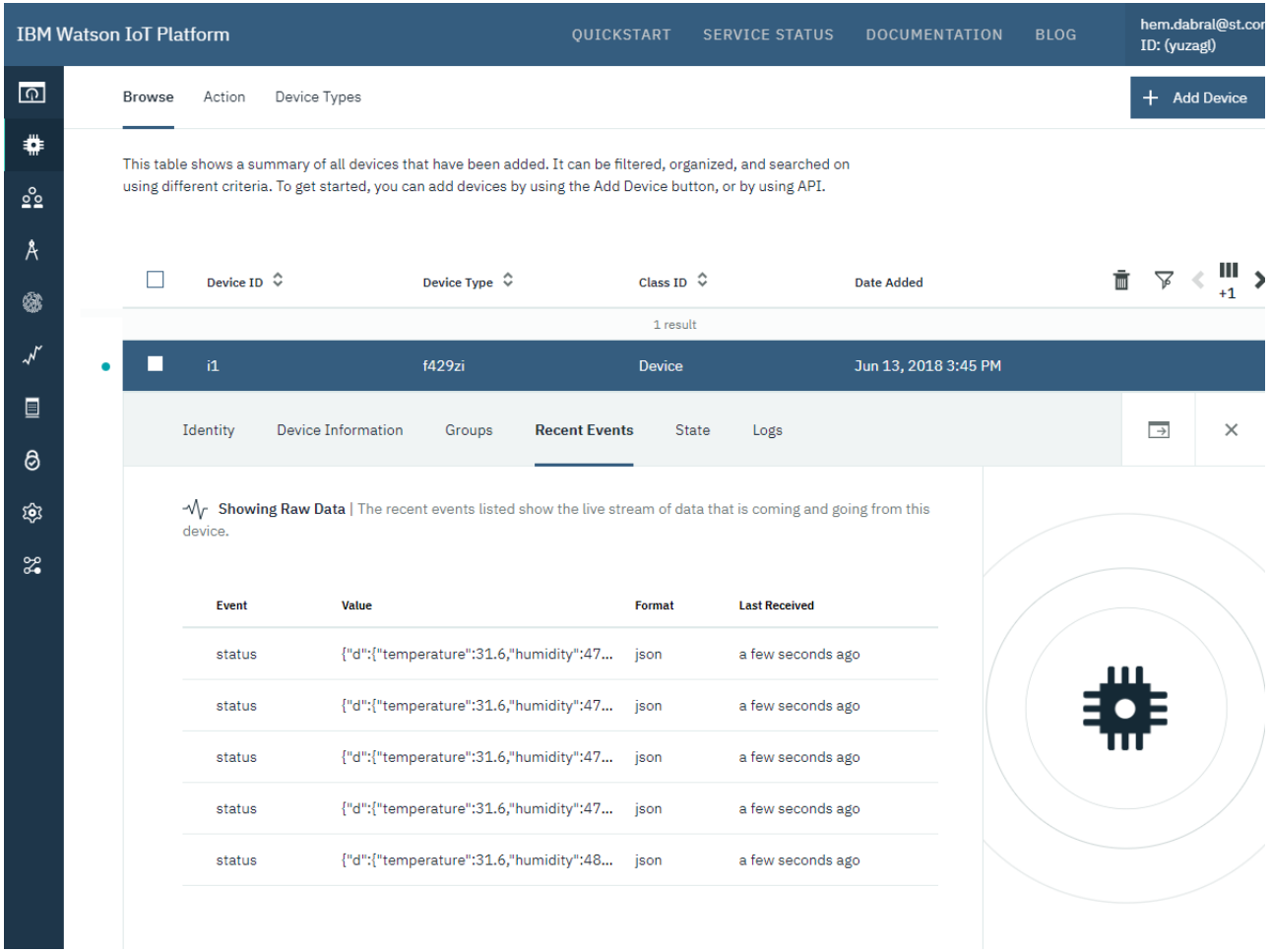
Provision of device credentials using NFC (optional) (2/2)

- Format of configuration string passed in step #5 on last slide:
  - OrgId=yuzagl;DeviceType=f429zi;DeviceId=i1;Token=hdd1hdd1



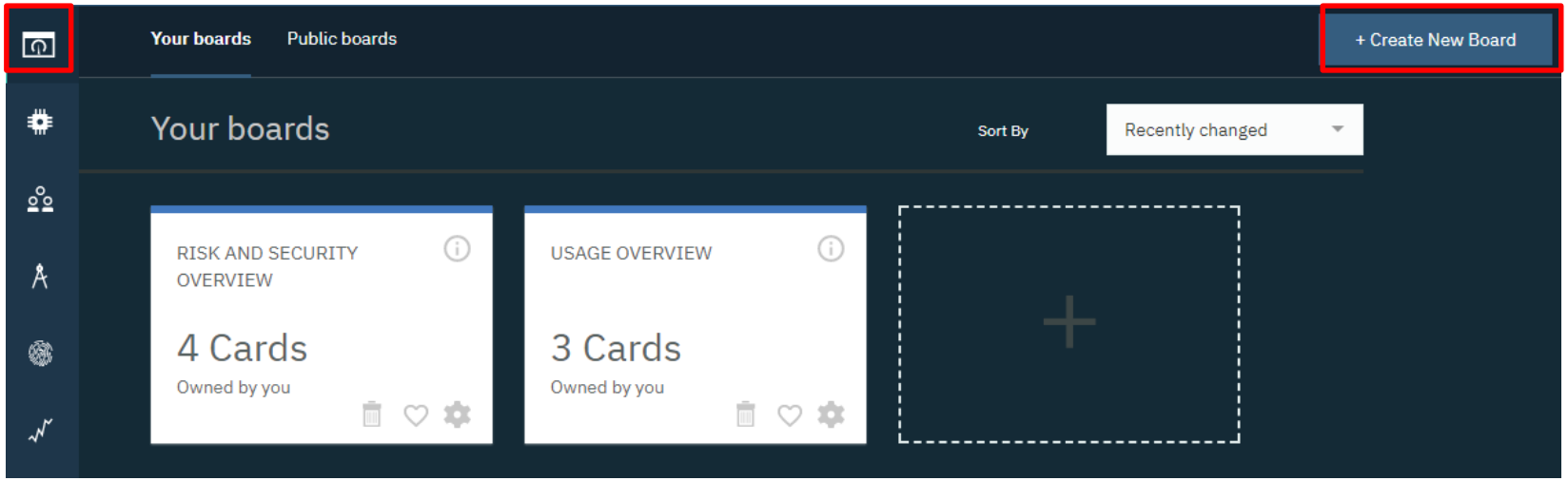
FP-CLD-WATSON1: Registered mode
Visualize messages received from STM32 Nucleo

- Browse devices, select your device ID, then click on **Recent Events** tab



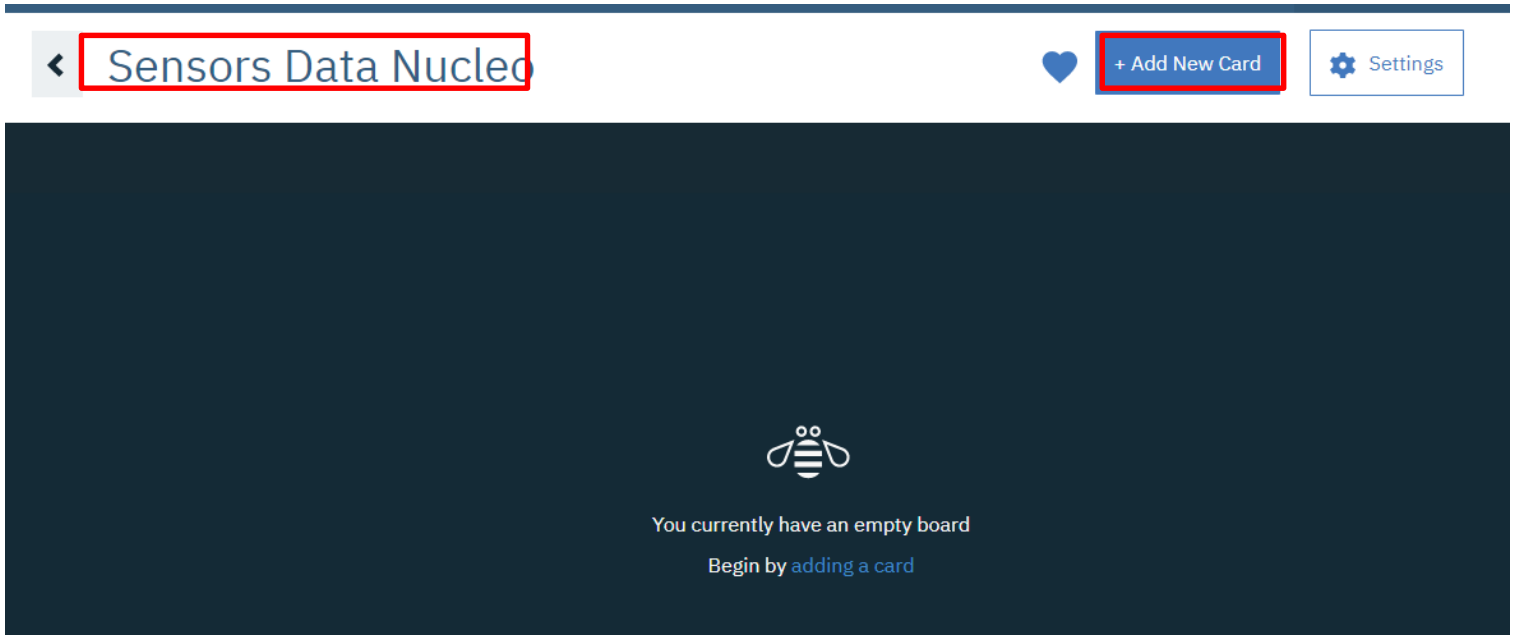
FP-CLD-WATSON1: Registered mode
Create dashboard to visualize data (1/4)

- Click on **Boards** in left bar, then **Create New Board**



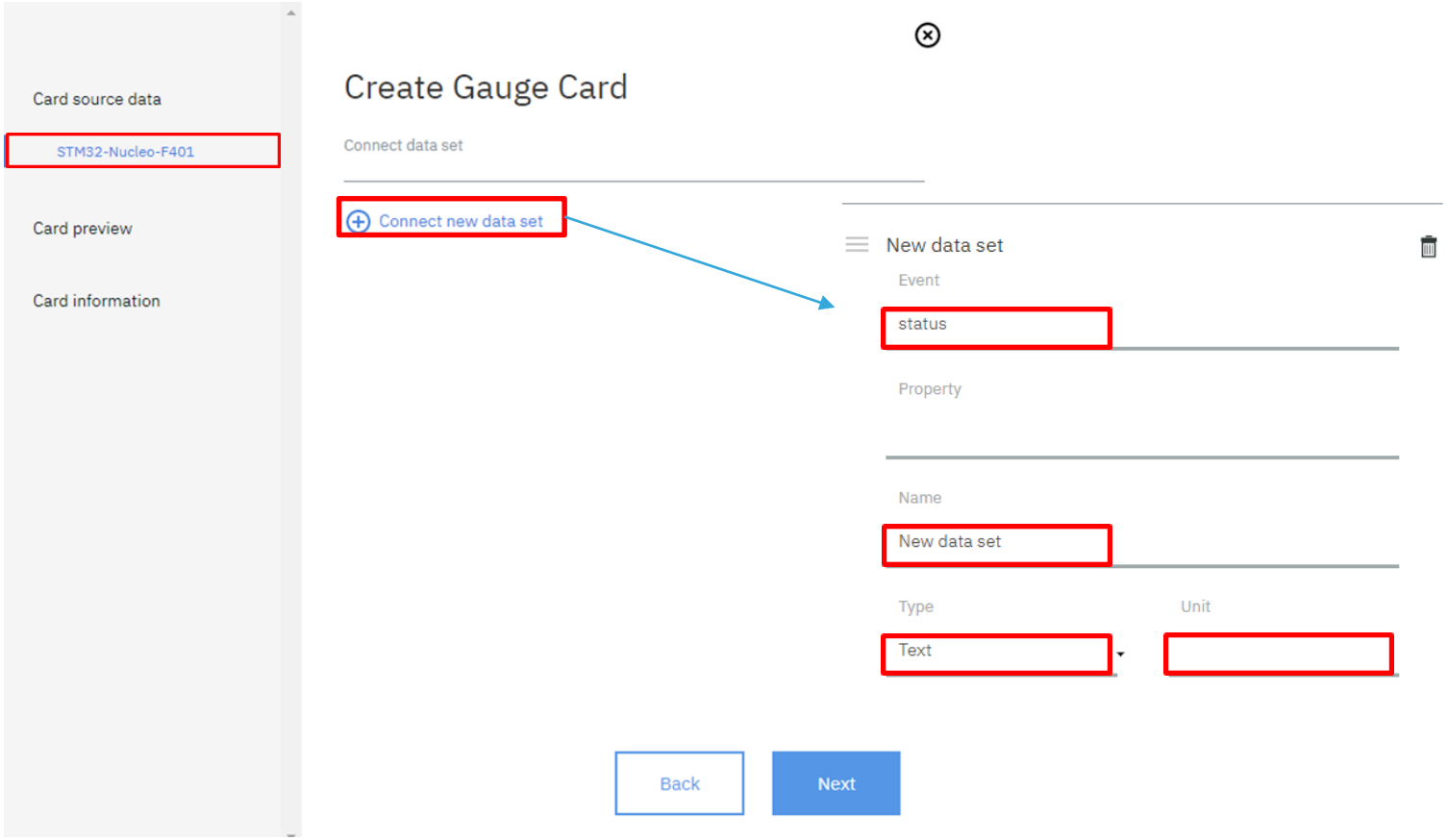
FP-CLD-WATSON1: Registered mode
Create dashboard to visualize data (2/4)

- Name your board, then click on **Add New Card**



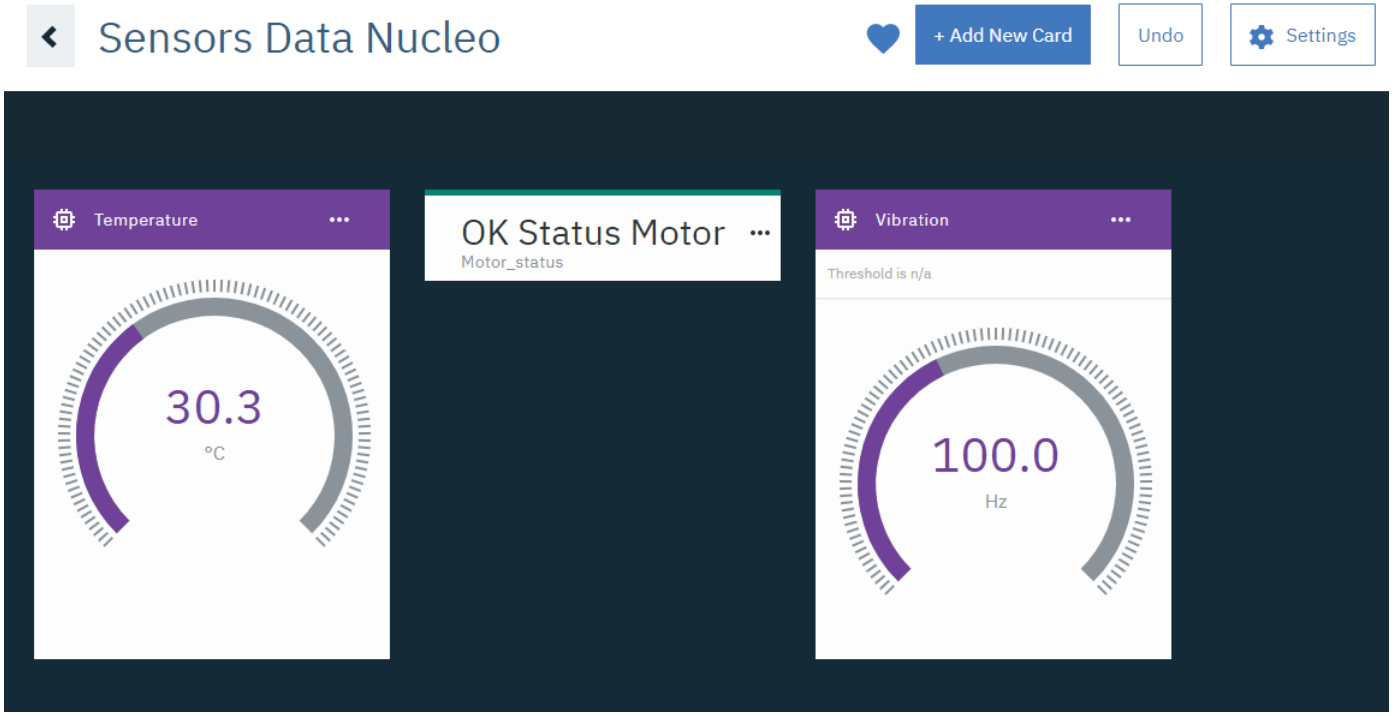
FP-CLD-WATSON1: Registered mode
Create dashboard to visualize data (3/4)

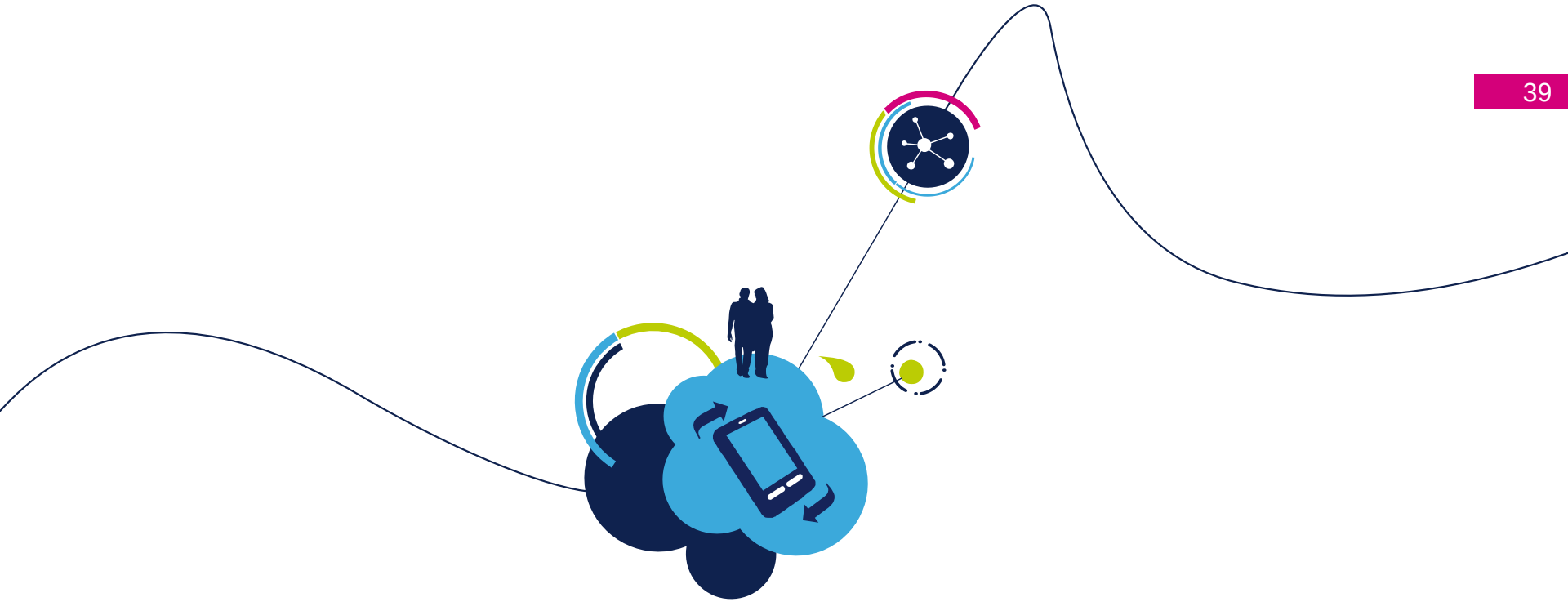
- Select Card Type, click on your device ID, then click on Connect data set.
- Select status as **Event;** select one among **data set** available in the messages received, select type and unit of the data set, then click **Next**



FP-CLD-WATSON1: Registered mode
Create dashboard to visualize data (4/4)

- For each data set contained in the messages generated by STM32 Nucleo (Temperature, Humidity, etc.), a different card can be added

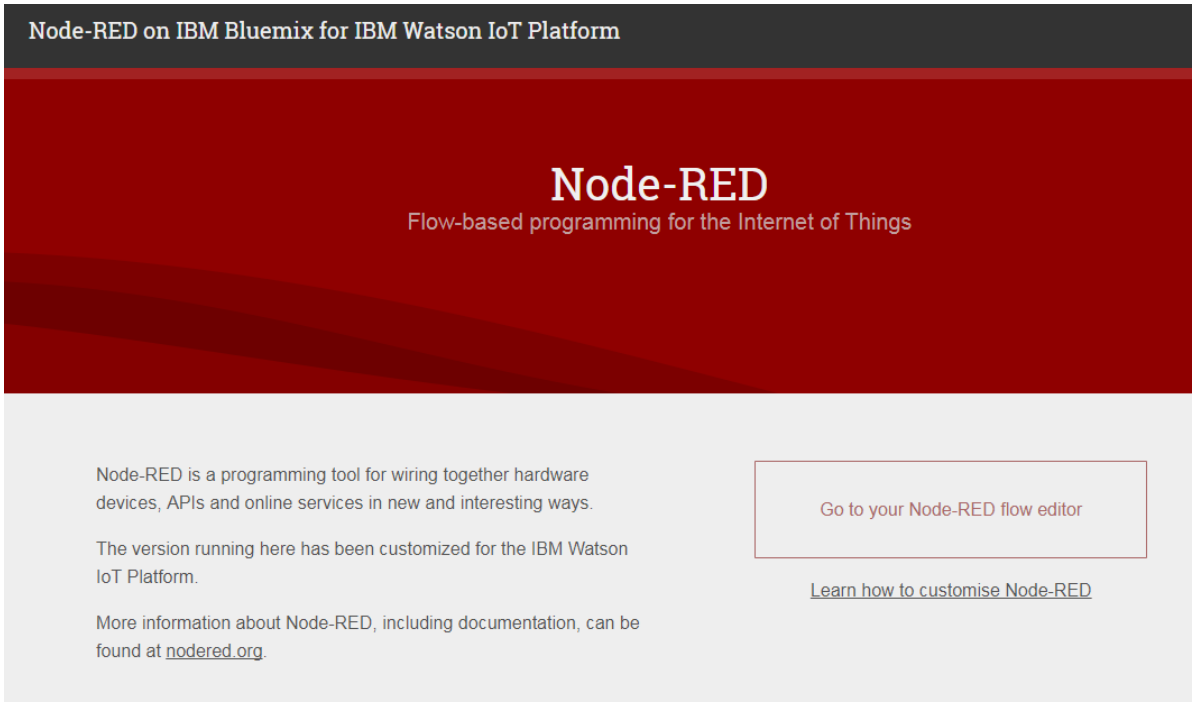




Registered mode configuration Connect device to a NodeRED application

FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- Node-RED is a flow-based development tool for wiring together hardware devices, APIs and online services (nodered.org)
- Node-RED is pre-integrated in Watson IoT Platform



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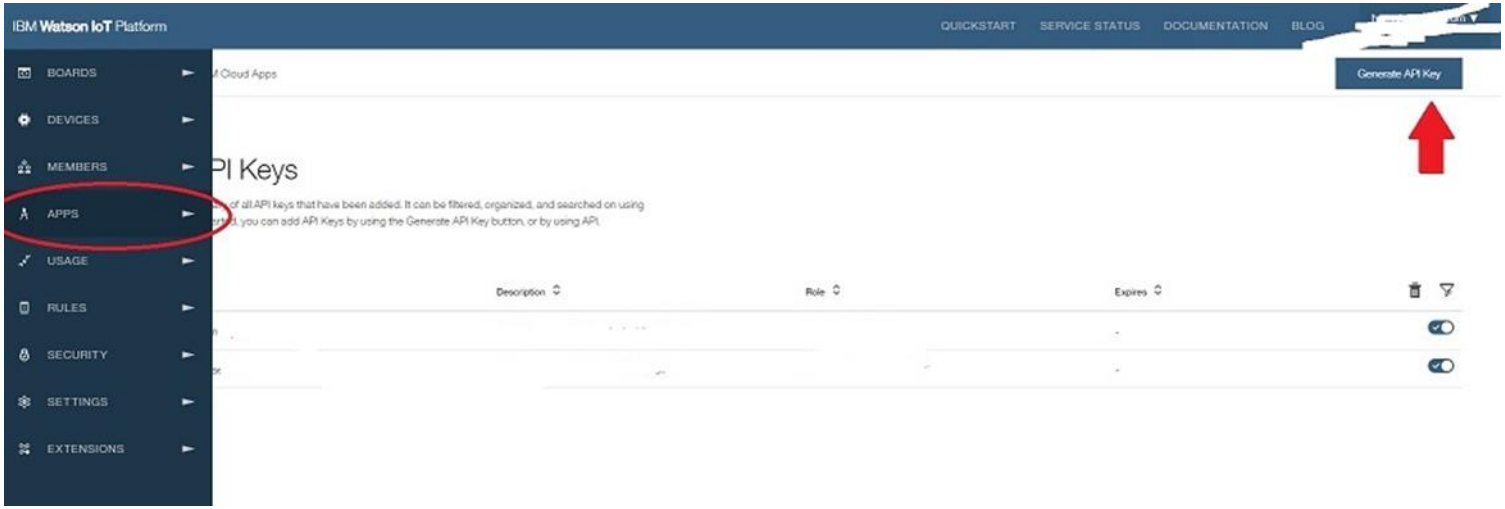
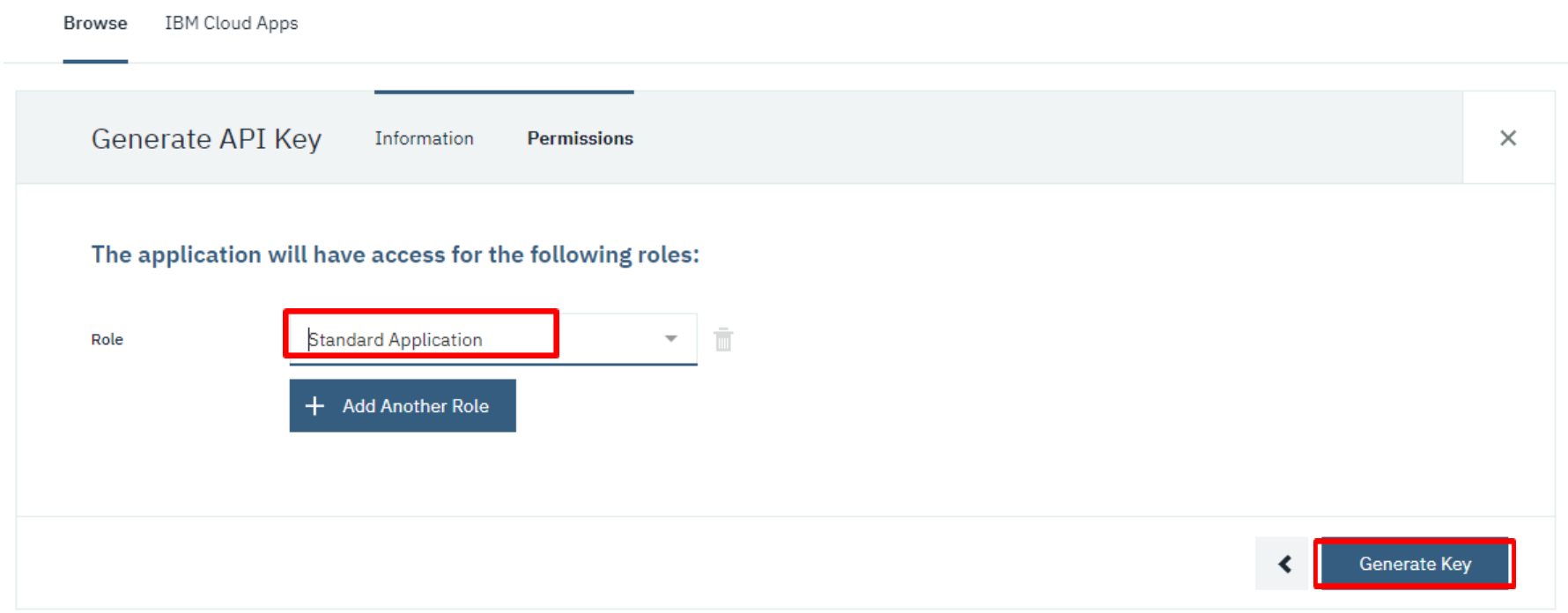
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- Before connecting your devices to Node-RED, you have to generate API keys in IBM Watson IoT dashboard



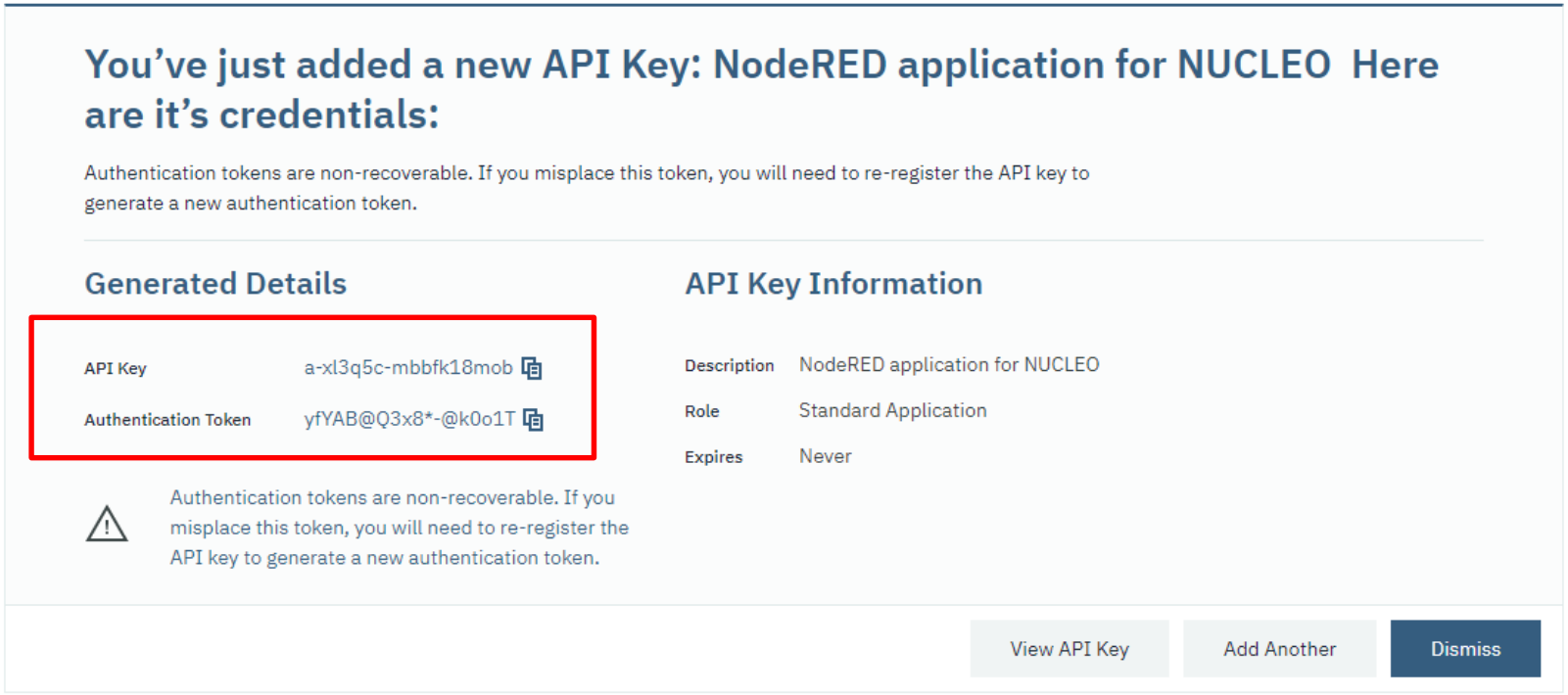
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- Select **Standard Application**, then click on **Generate Key**



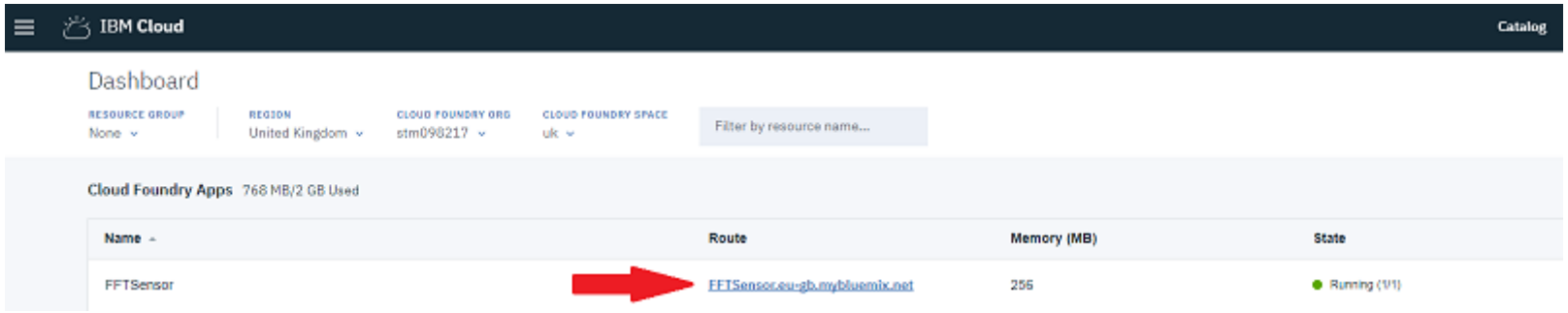
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- Note down API Key and Authentication token



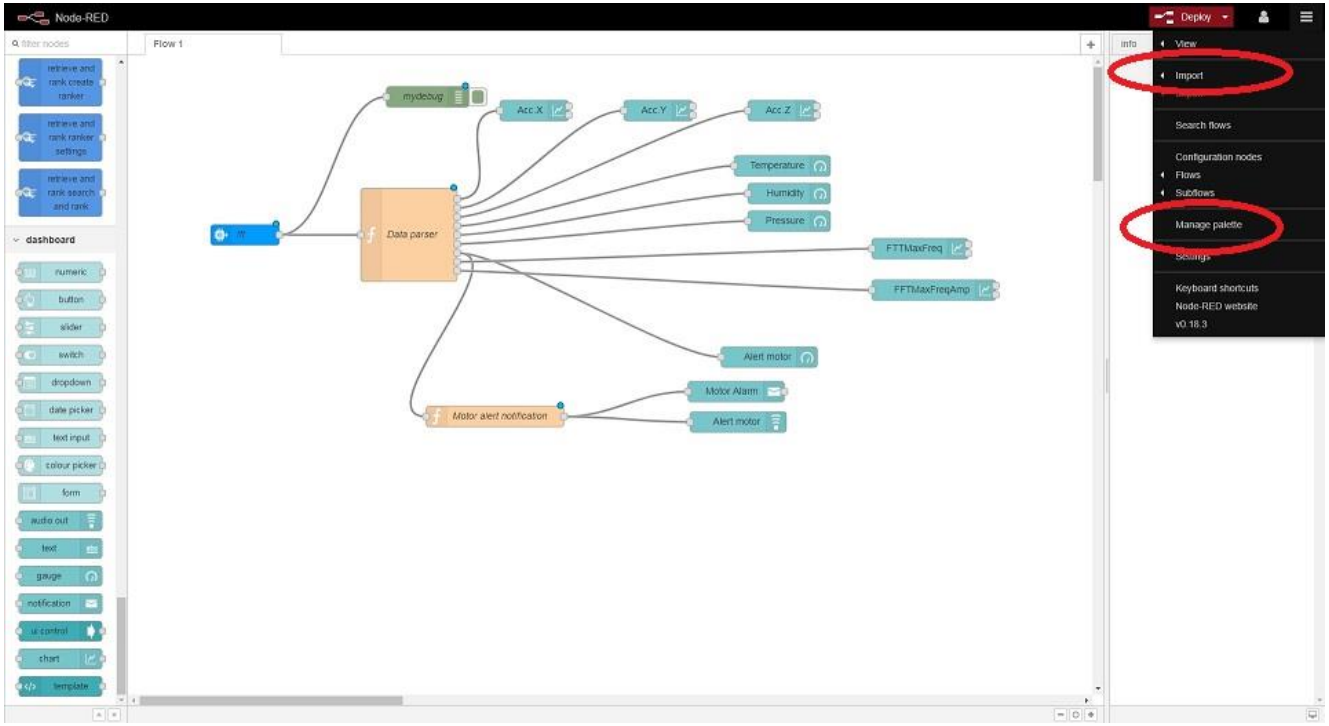
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- Go back to your IBM Cloud dashboard and click on your app URL to open Node-RED flow editor. It is optional to secure it using a username/password



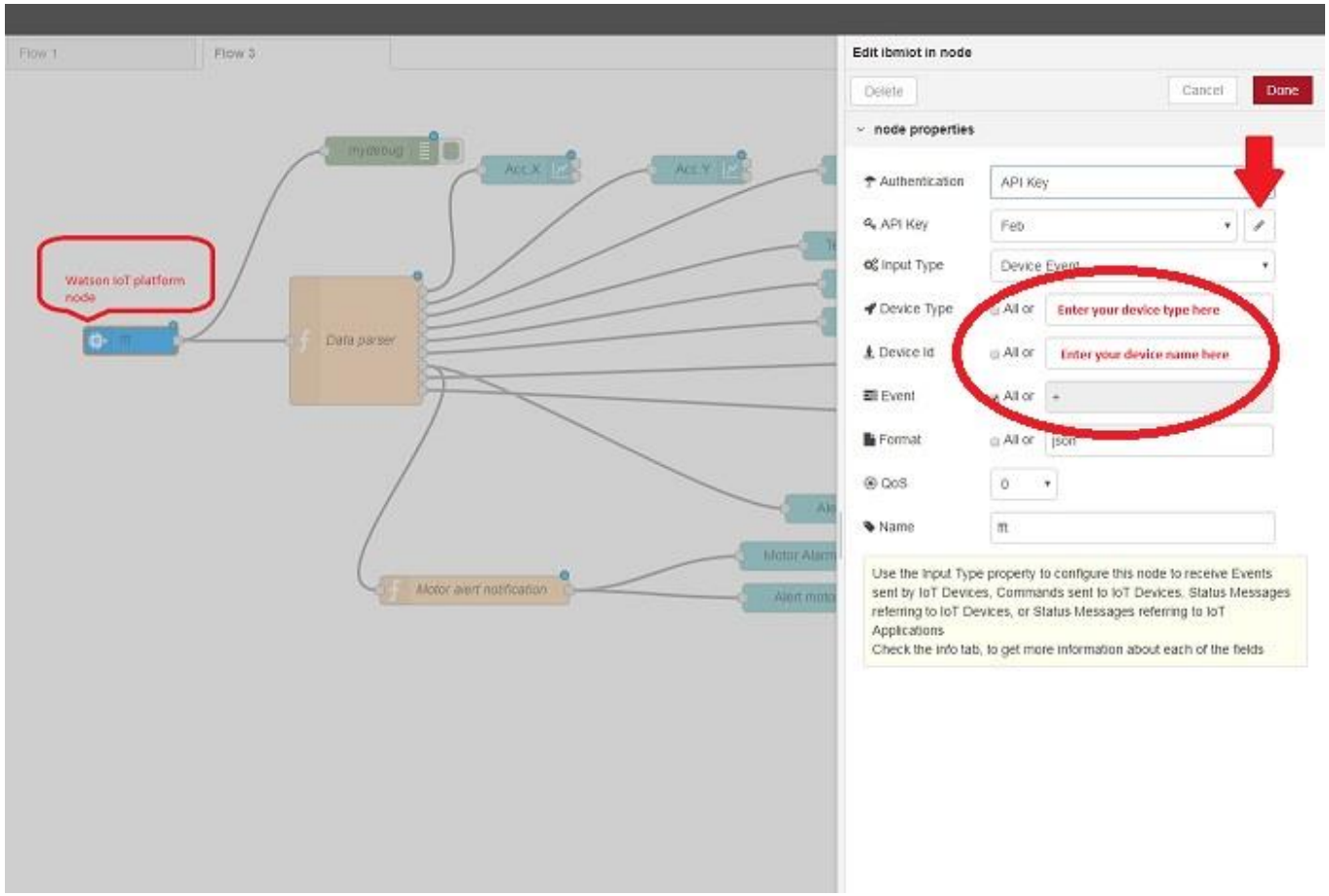
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- In Node-RED flow editor, select **Manage Palette** from menu option, click on **install tab** and install ***node-red-dashboard*** in your Node-RED palette
- Select **Import** to import the flow described in file *FFTSensorFlow.json* that can be found inside folder *STM32CubeFunctionPack_WATSON1_F4_V2.1.1/Utilities/NodeRED*
- Copy and paste the content of the JSON file to clipboard



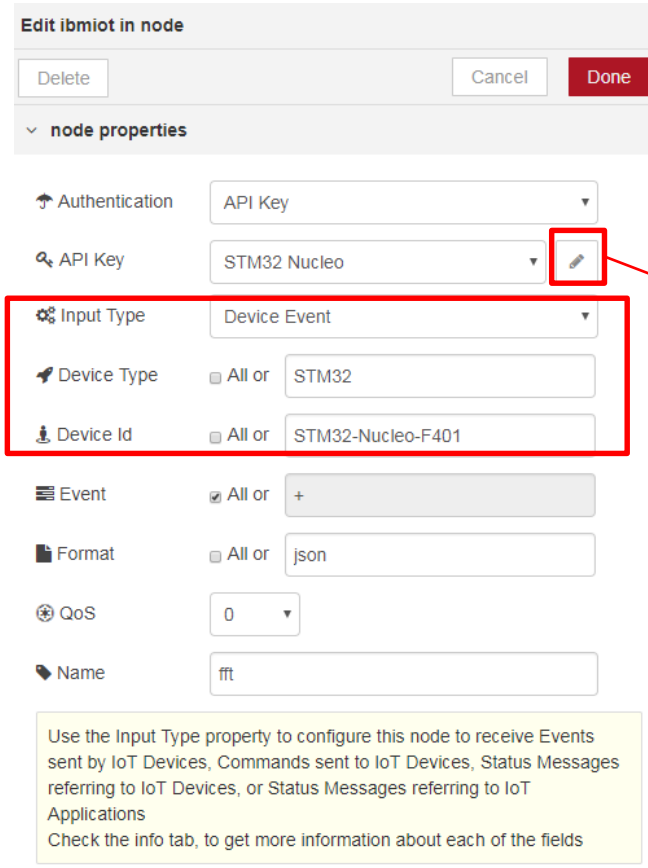
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

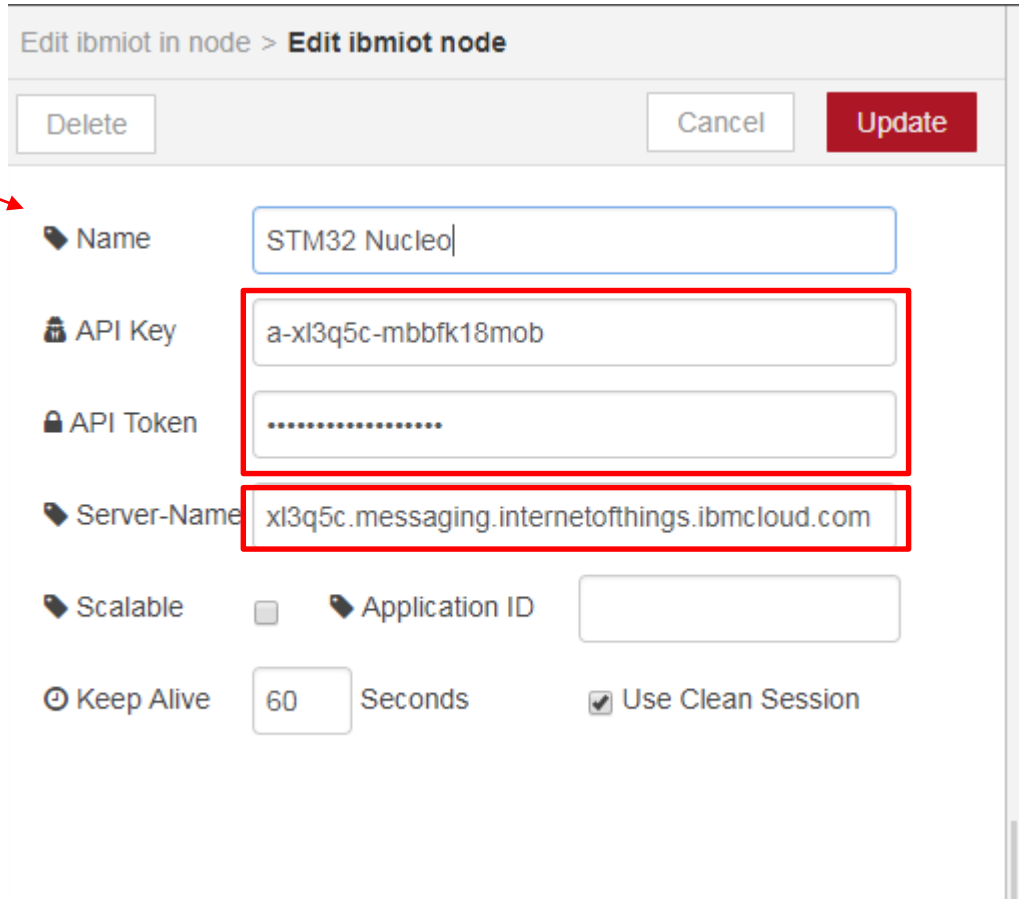
- Configure the ***Watson IoT platform node*** using following parameters**:**
  - API key and authentication token
  - Device Type
  - Device ID



FP-CLD-WATSON1: Registered mode

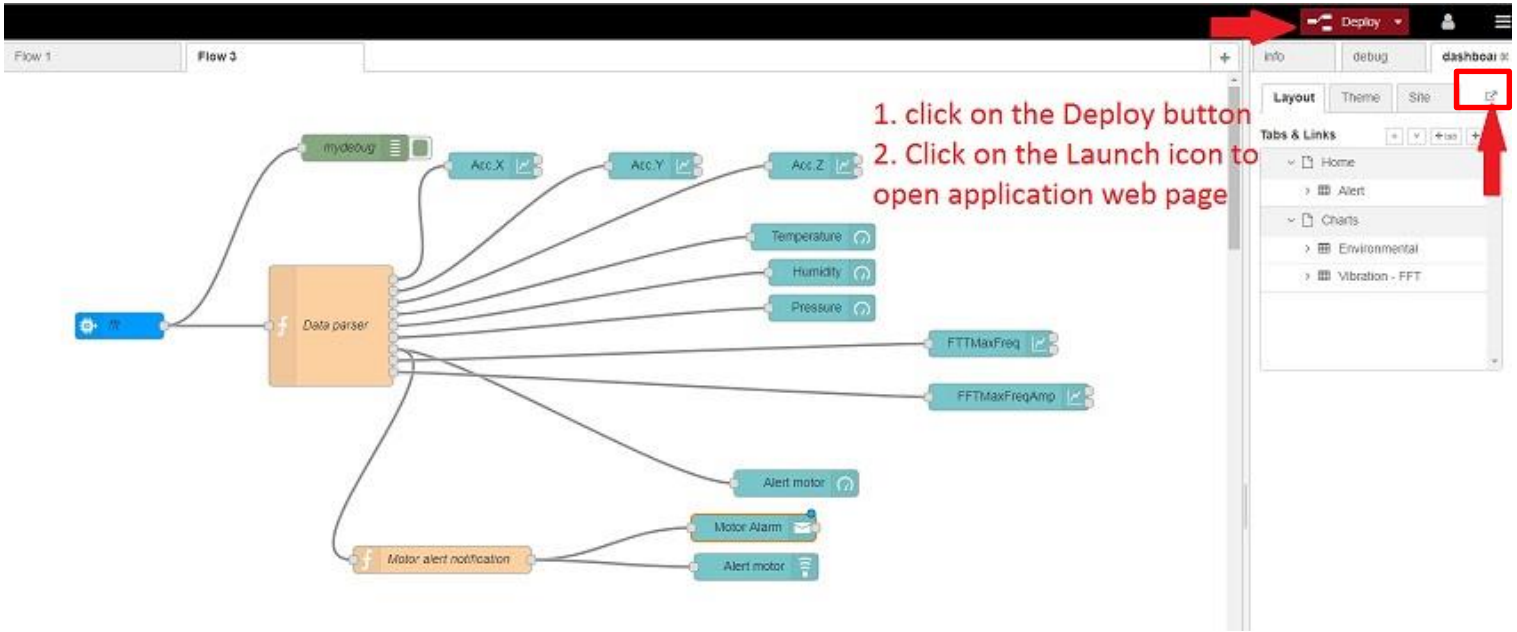
Connect device to Node-RED application





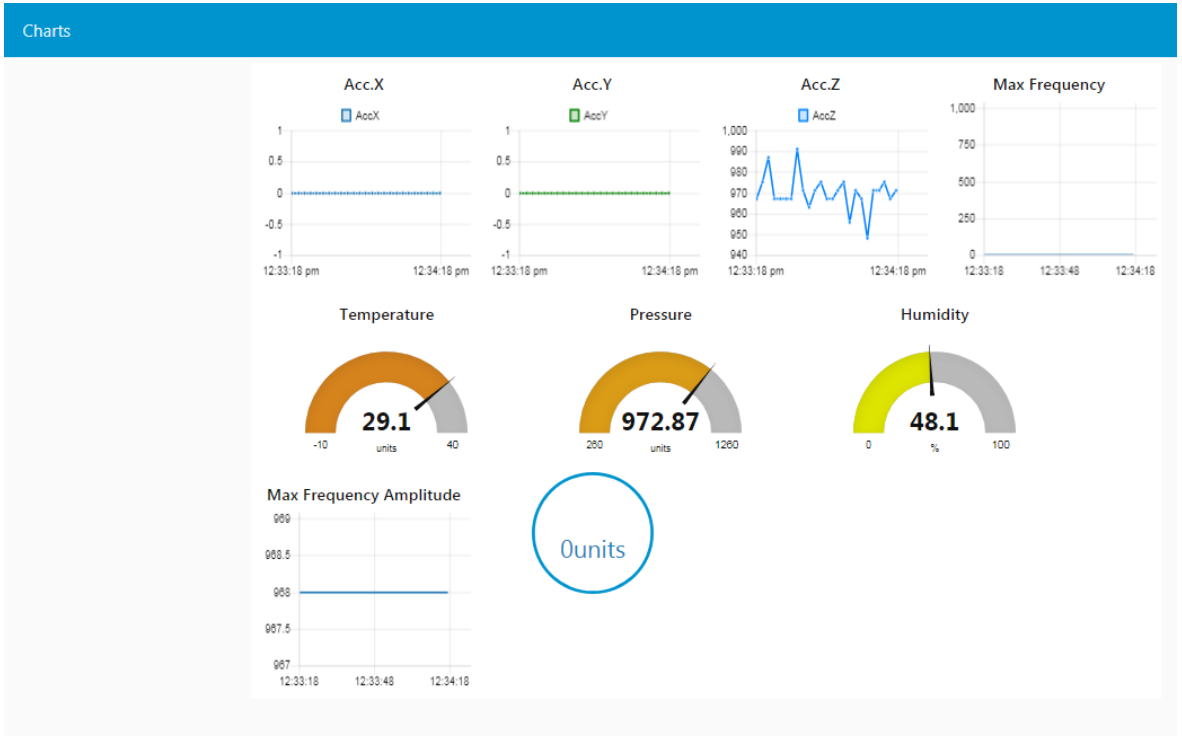
FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

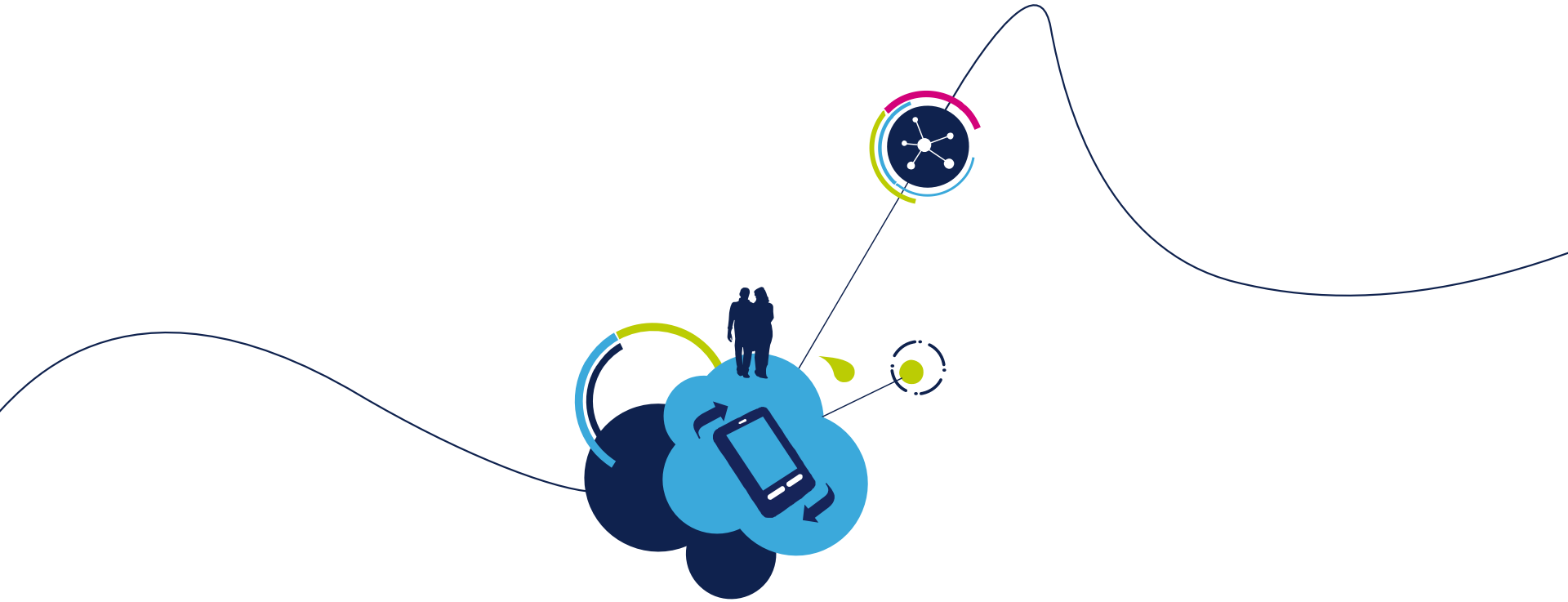
- In order to visualize the sensor data received from STM32 Nucleo in Node-RED dashboard:
  - Click on the Deploy button on top-right of the Node-RED application page
  - Click launch icon in dashboard tab



FP-CLD-WATSON1: Registered mode
Connect device to Node-RED application

- A web based dashboard will appear. Sensor data from STM32 Nucleo is visualized in real time



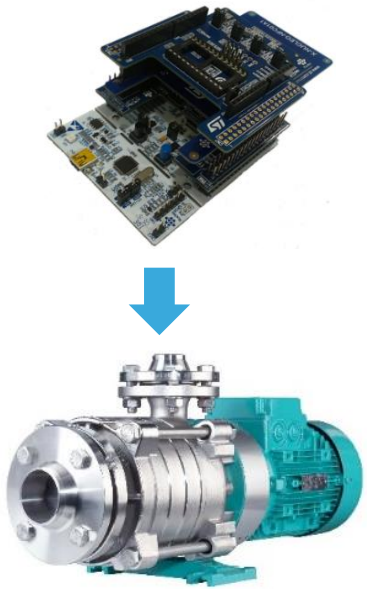


Application scenario

Condition Monitoring Sensor to Cloud

Pre-Integrated Application Packages

FP-CLD-WATSON1 - Condition monitoring data Wi-Fi to Cloud



Demo kit mounted on top of Motor/Pump/Fan

Vibration data pushed to IBM cloud over WIFI.
Condition levels for motor: "OK, Warning, Failure"

- **Condition monitoring and preventive maintenance**
- **Vibration monitoring of motors, fans and pumps**
- **Identification of load unbalance and misalignment**
- **Alarming of equipment failures**

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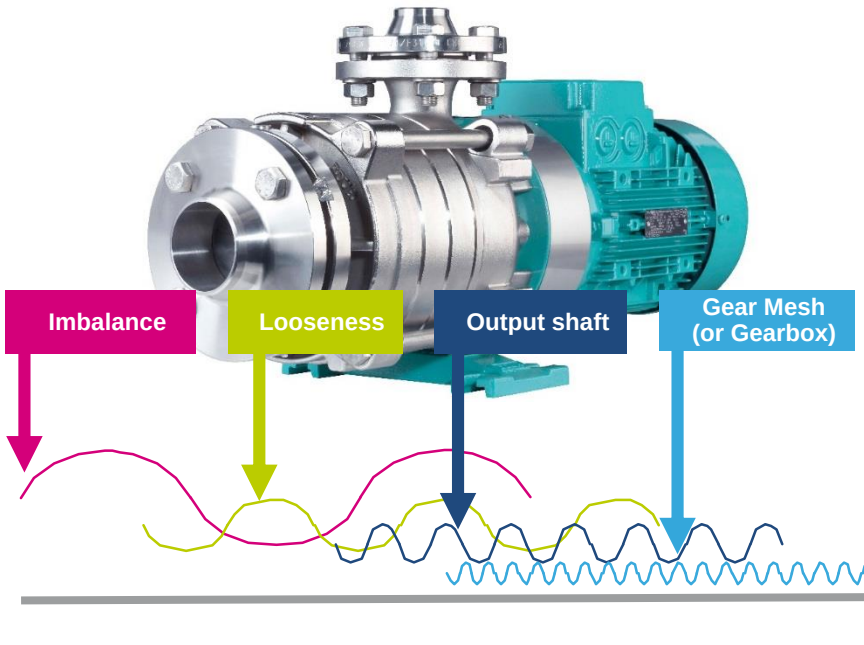
Typical Use Case of Monitoring Industrial Motor

Mechanical vibration

- Displacement
- Speed
- Acceleration
- Acoustic noise
- Angular speed
- Torque

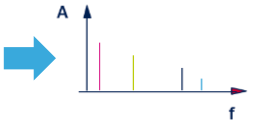


Functionality

Vibration Capture

Connectivity

Wireless Connectivity



Processing

Secure Connections

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Quick Start Guide Contents

FP-CLD-WATSON1: STM32Cube function pack for IoT node with Wi-Fi, NFC and sensors for vibration analysis, connected to IBM Watson IoT cloud

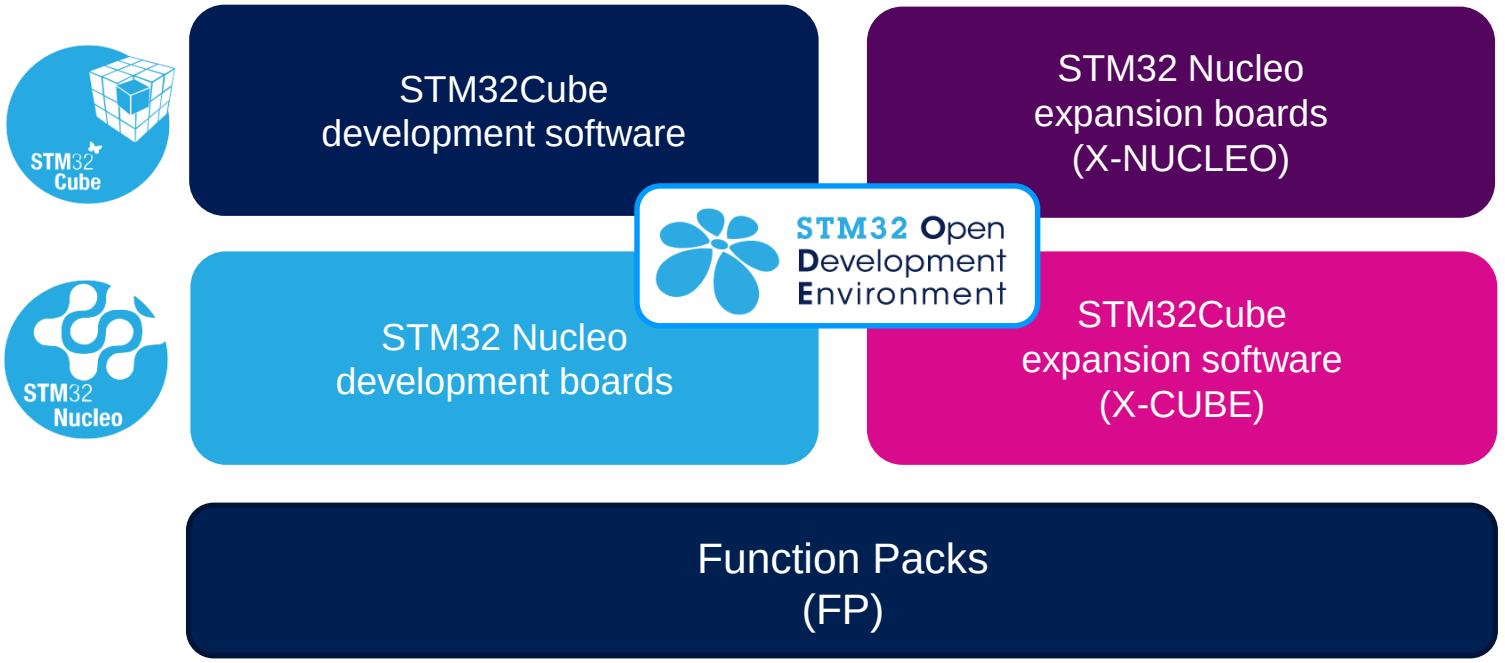
Setup & Demo Examples

Documents & Related Resources

STM32 Open Development Environment: Overview

STM32 Open Development Environment
Fast, affordable Prototyping and Development

- The STM32 Open Development Environment (ODE) consists of a set of stackable boards and a modular open SW environment designed around the STM32 microcontroller family.



www.st.com/stm32ode

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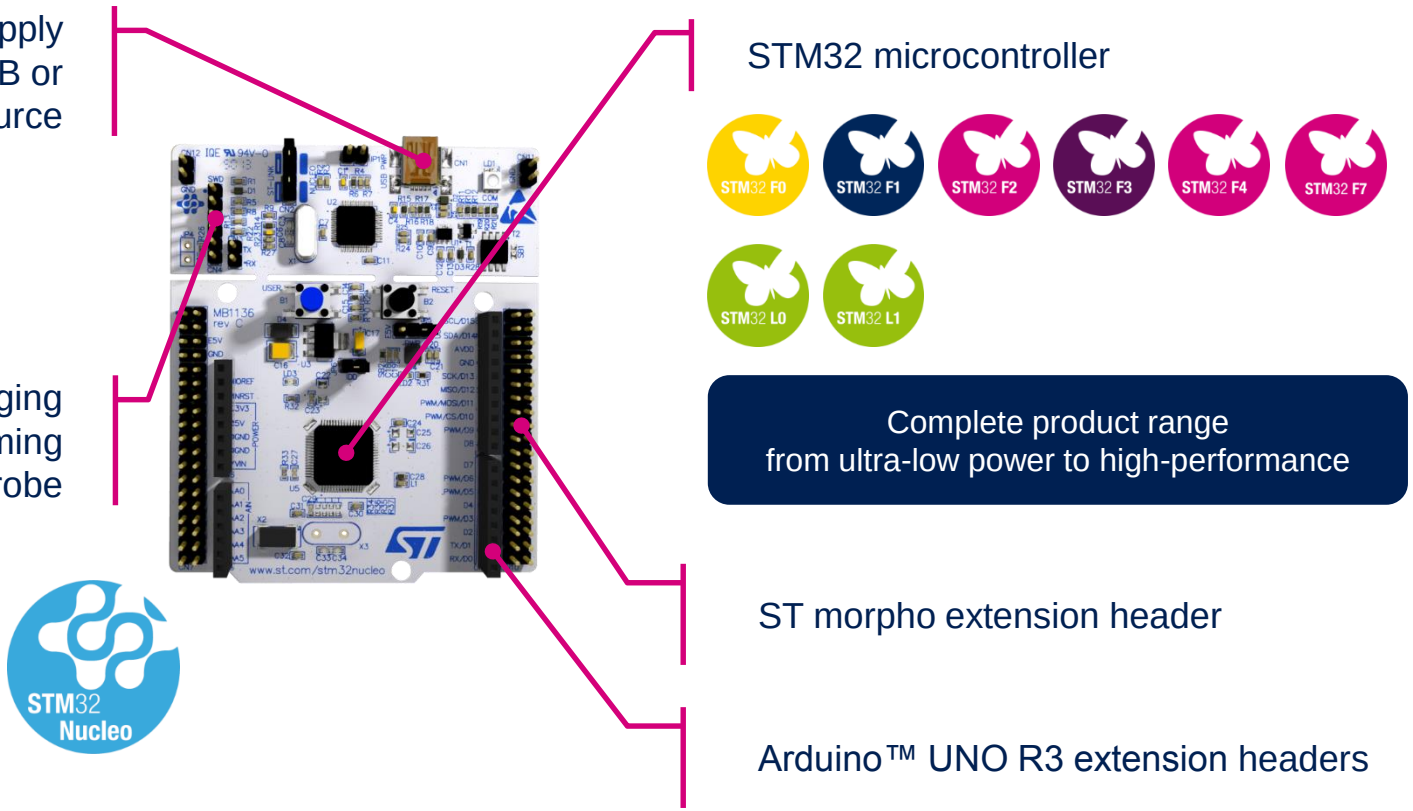
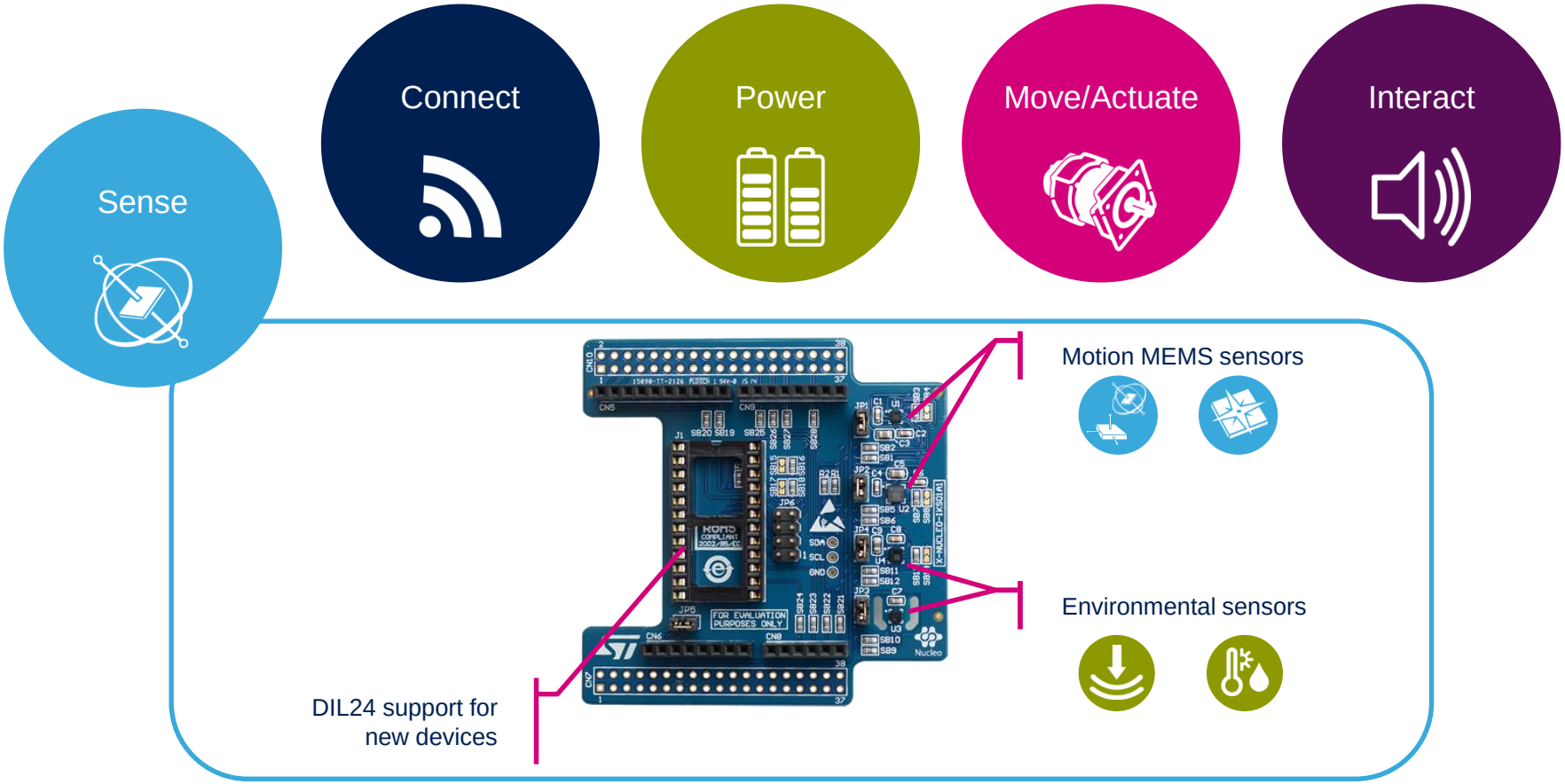
Development Boards (NUCLEO)

- A comprehensive range of affordable development boards for all the STM32 microcontroller series, with unlimited unified expansion capabilities and integrated debugger/programmer functionality.



Expansion Boards (X-NUCLEO)

- Boards with additional functionality that can be plugged directly on top of the STM32 Nucleo development board directly or stacked on another expansion board.



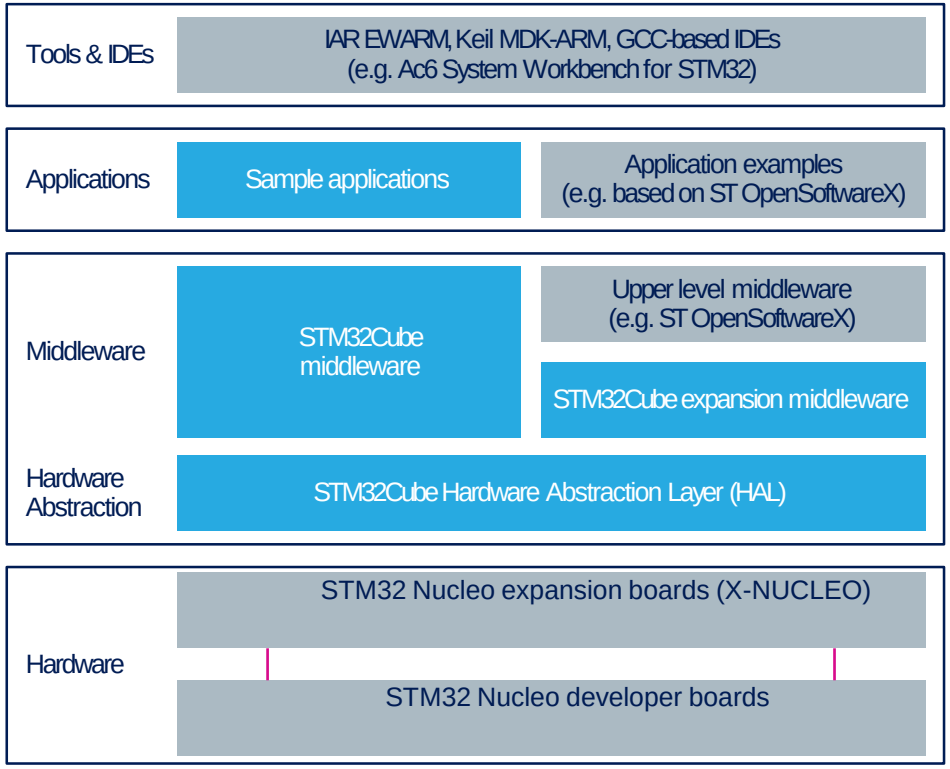
Example of STM32 expansion board (X-NUCLEO-IKS01A1)

STM32 Open Development Environment

Software components

- **STM32Cube software (CUBE)** - A set of free tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer and middleware bricks.

- **STM32Cube expansion software (X-CUBE)** - Expansion software provided free for use with the STM32 Nucleo expansion board and fully compatible with the STM32Cube software framework. It provides abstracted access to expansion board functionality through high-level APIs and sample applications.



- **Compatibility with multiple Development Environments -** The STM32 Open Development Environment is compatible with a number of IDEs including IAR EWARM, Keil MDK, and GCC-based environments. Users can choose from three IDEs from leading vendors, which are free of charge and deployed in close cooperation with ST. These include Eclipse-based IDEs such as Ac6 System Workbench for STM32 and the MDK-ARM environment.

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OPEN LICENSE MODELS: STM32Cube software and sample applications are covered by a mix of fully open source BSD license and ST licenses with very permissive terms.

www.st.com/stm32cube

www.st.com/x-cube

STM32 Open Development Environment

Building block approach

The building blocks	Your need	Our answer

Accelerometer, gyroscope
Inertial modules, magnetometer
Pressure, temperature, humidity
Proximity, microphone

Sense — COLLECT

Bluetooth LE, Sub-GHz radio
NFC, Wi-Fi, GNSS

Connect — TRANSMIT

Audio amplifier
Touch controller
Operation Amplifier

Translate — ACCESS

Stepper motor driver
DC & BLDC motor driver
Industrial input / output

Move / Actuate — CREATE

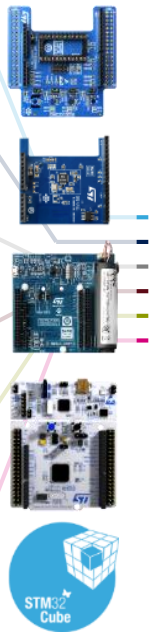
Energy management & battery

Power — POWER

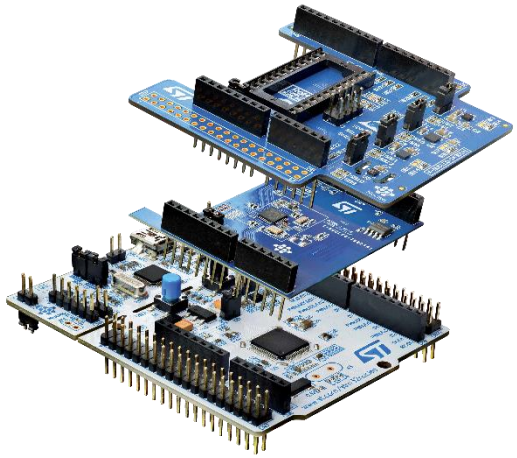
General-purpose microcontrollers
Secure microcontrollers

Process — PROCESS

Software



STM32 Open Development Environment



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