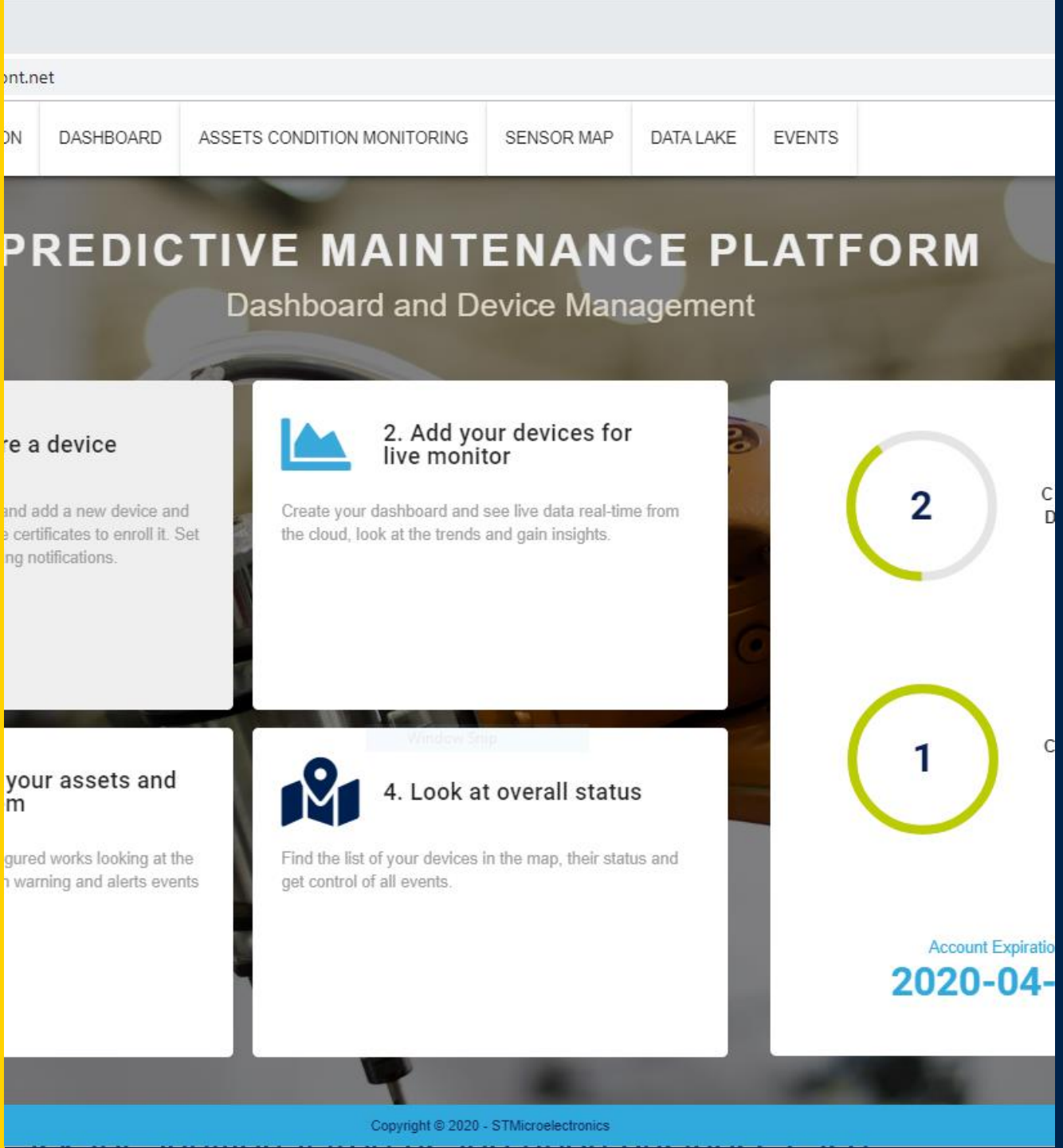

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Getting Started
DSH-PREDMNT and PREDMNT Solutions

Agenda

1 Architecture

2 Run the application

3 Condition Monitoring with Wired Connectivity:
Get started with SL-PREDMNT-E2C

4 Condition Monitoring with Wireless Connectivity:
Get started with SL-PREDMNT-S2C

5 Anomaly Detection with NanoEdge AI Studio Libraries:
Get started with STWIN and FP-AI-PREDMNT2

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Predictive Maintenance Dashboard
Why, how, what?

STMicroelectronics wants to enable customers to fast implement Proof Of Concept on condition monitoring and predictive maintenance from an end to end perspective.

STMicroelectronics, on top of providing evaluation tools and software libraries, allows to connect its devices on a cloud application.

Predictive Maintenance Dashboard is a Cloud application based on AWS services that allows to collect, visualize and analyze data streamed by Sensor Units tailored for Vibration, Environmental and Ultrasound condition monitoring.

Condition monitoring & Anomaly Detection edge processing enabling end-to-end

Ultrasound, vibration, environmental condition monitoring and anomaly detection

Edge

Cloud Application for device management

Smart Sensor Nodes

STEVAL-IDP004V2

STEVAL-BFA001V2B

Serial Connectivity

STEVAL-STWINKT1B

NANOEDGE AI STUDIO

Wi-Fi Connectivity / LTE

Edge Processing

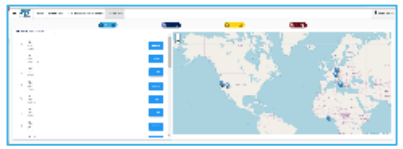
STM32MP157F-DK2

ST Connectivity SDKs

AWS IoT Greengrass

Cloud Application

powered by aws



AWS IoT Core

AWS Shield

AWS Lambda

AWS WAF

Amazon DynamoDB

Amazon Cognito

Amazon Simple Storage Service (S3)

Amazon API Gateway

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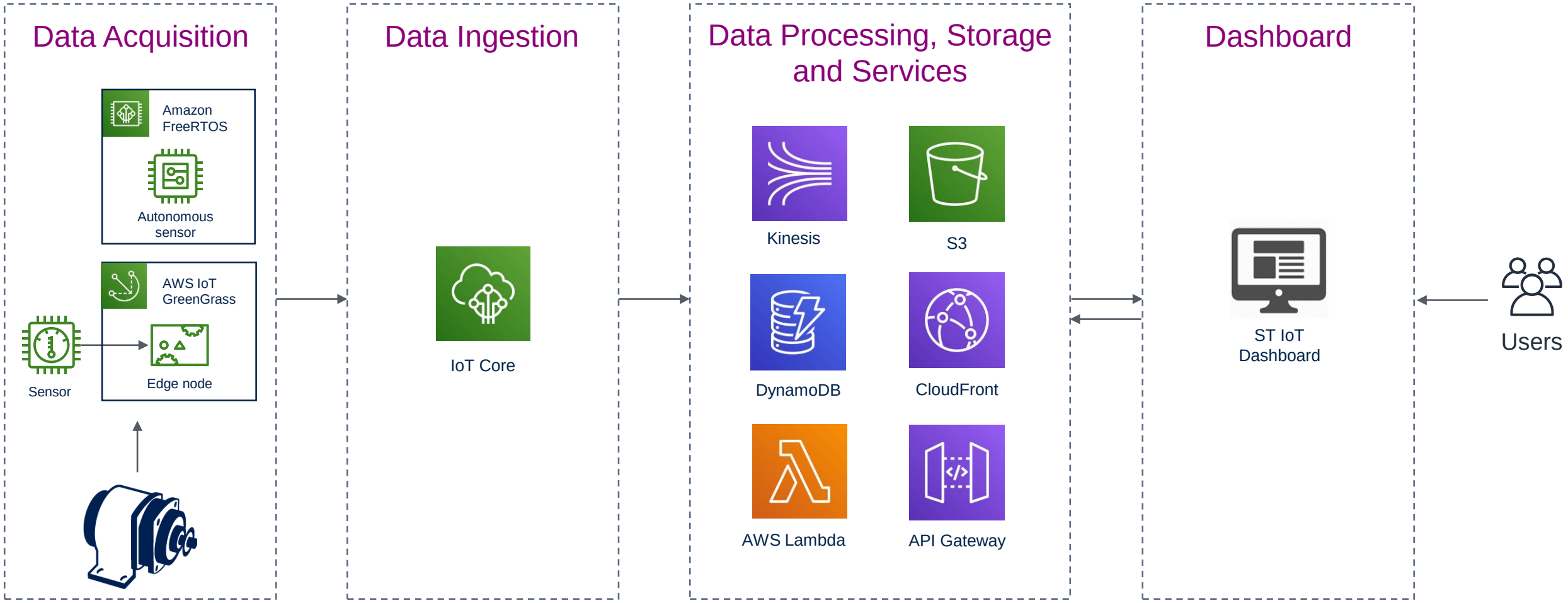
Simplified Architecture



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Predictive Maintenance Dashboard

AWS services by class

Management and Governance

Amazon CloudWatch

AWS CloudFormation

Networking and Content Delivery

Amazon CloudFront

Amazon API Gateway

Application core modules: IoT, Compute, Database and Storage

AWS IoT Core

AWS IoT Greengrass

Kinesis

AWS Lambda

Amazon DynamoDB

Amazon Simple Storage Service (S3)

User identify and security

Amazon Cognito

AWS Shield

AWS Identity and Access Management (IAM)

AWS WAF

powered by aws

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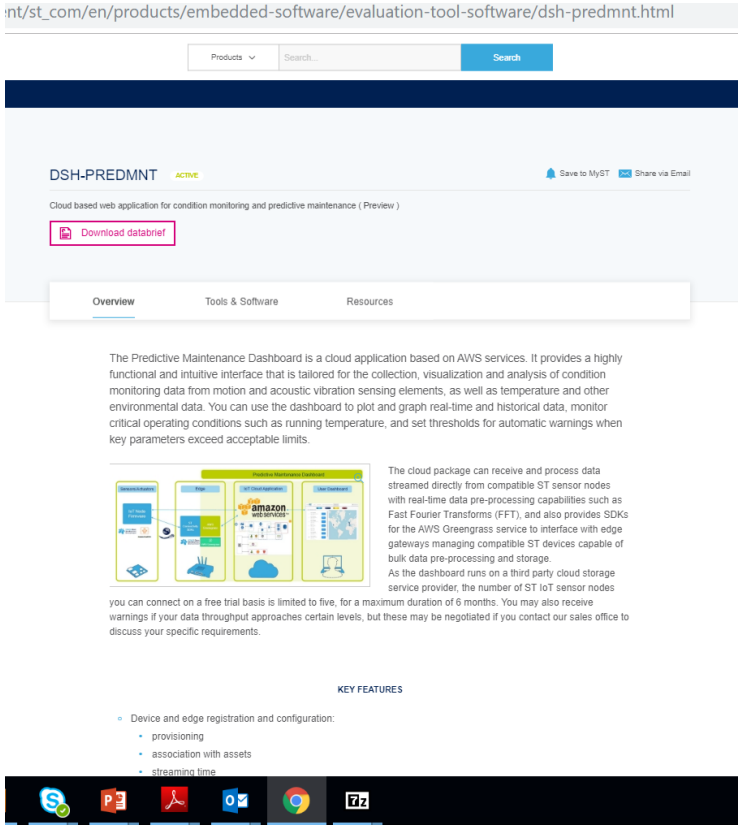
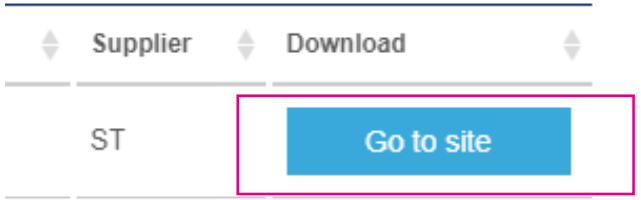
Predictive Maintenance Dashboard
How can I access?

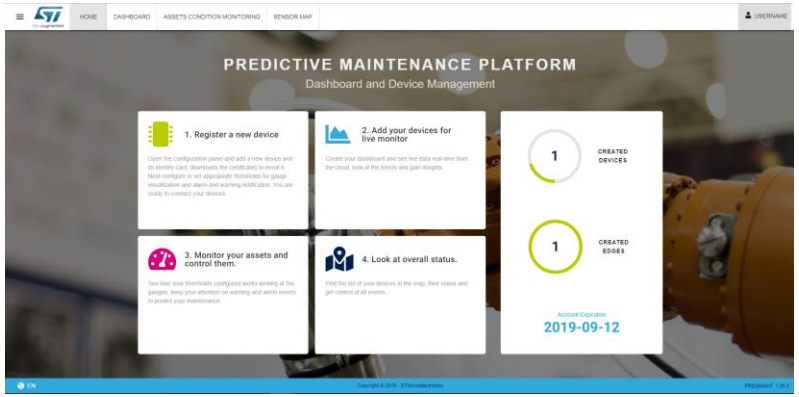
https://www.st.com/content/st_com/en/products/embedded-software/evaluation-tool-software/dsh-predmnt.html



ST.com/DSH-Predmnt



- dsh-predmnt.st.com



*regulated with terms of usage for free limited access

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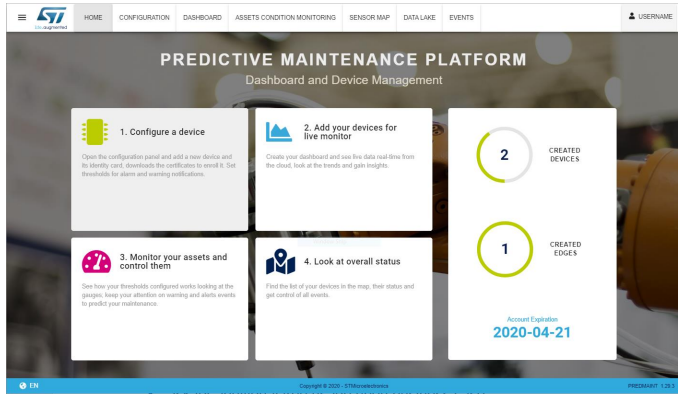
Run the application

Predictive Maintenance Dashboard
Run the Application in limited free usage

ST.com/DSH-Predmnt

Supplier	Download
ST	Go to site
ST	Get Software

- dsh-predmnt.st.com



- Serverless deployment in customer's account

Terms of usage:

- Max 5 devices
- Max 6 months from license agreement acceptance

When user runs out of conditions:

- user can download data
- decide whether or not open its own AWS account
- ask for additional free usage upon business case

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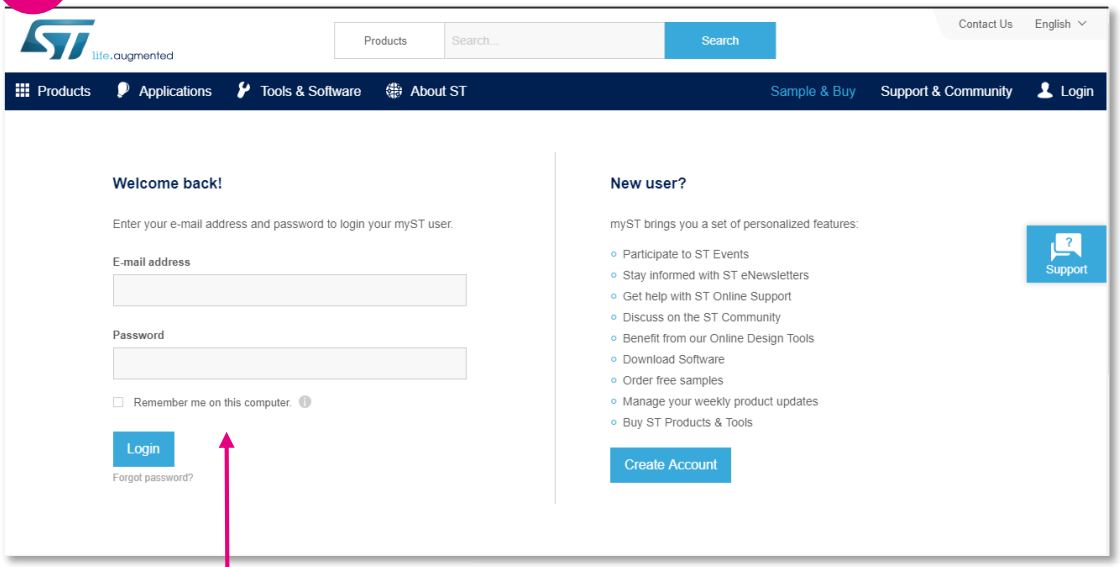
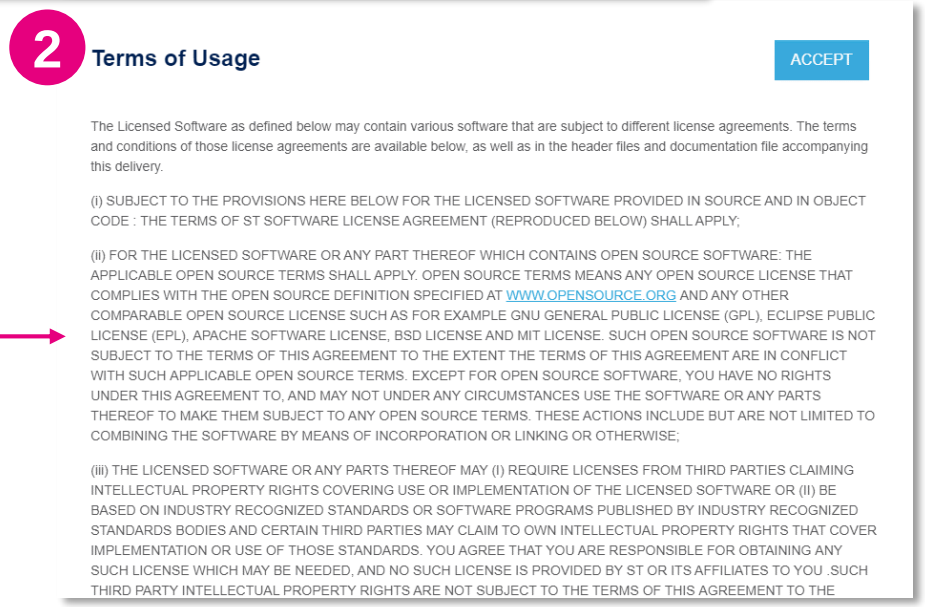
Login
Sign the Terms of Usage and go

1

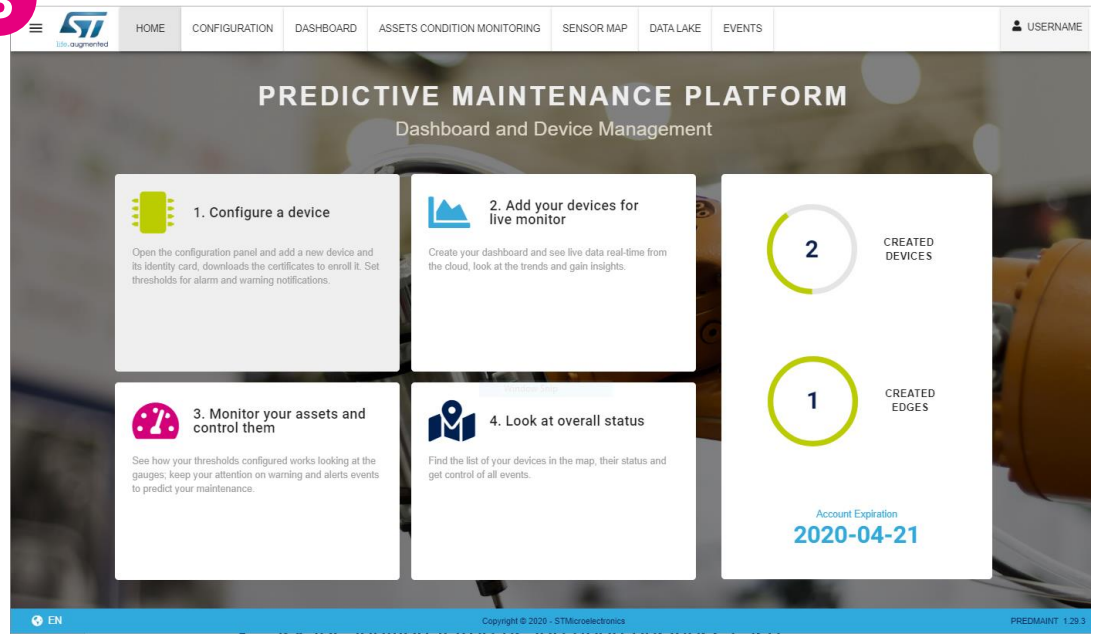


login and accept Terms of Usage

2



3



Redirect to the dashboard

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Predictive Maintenance Dashboard
DSH-PREDMNT Features

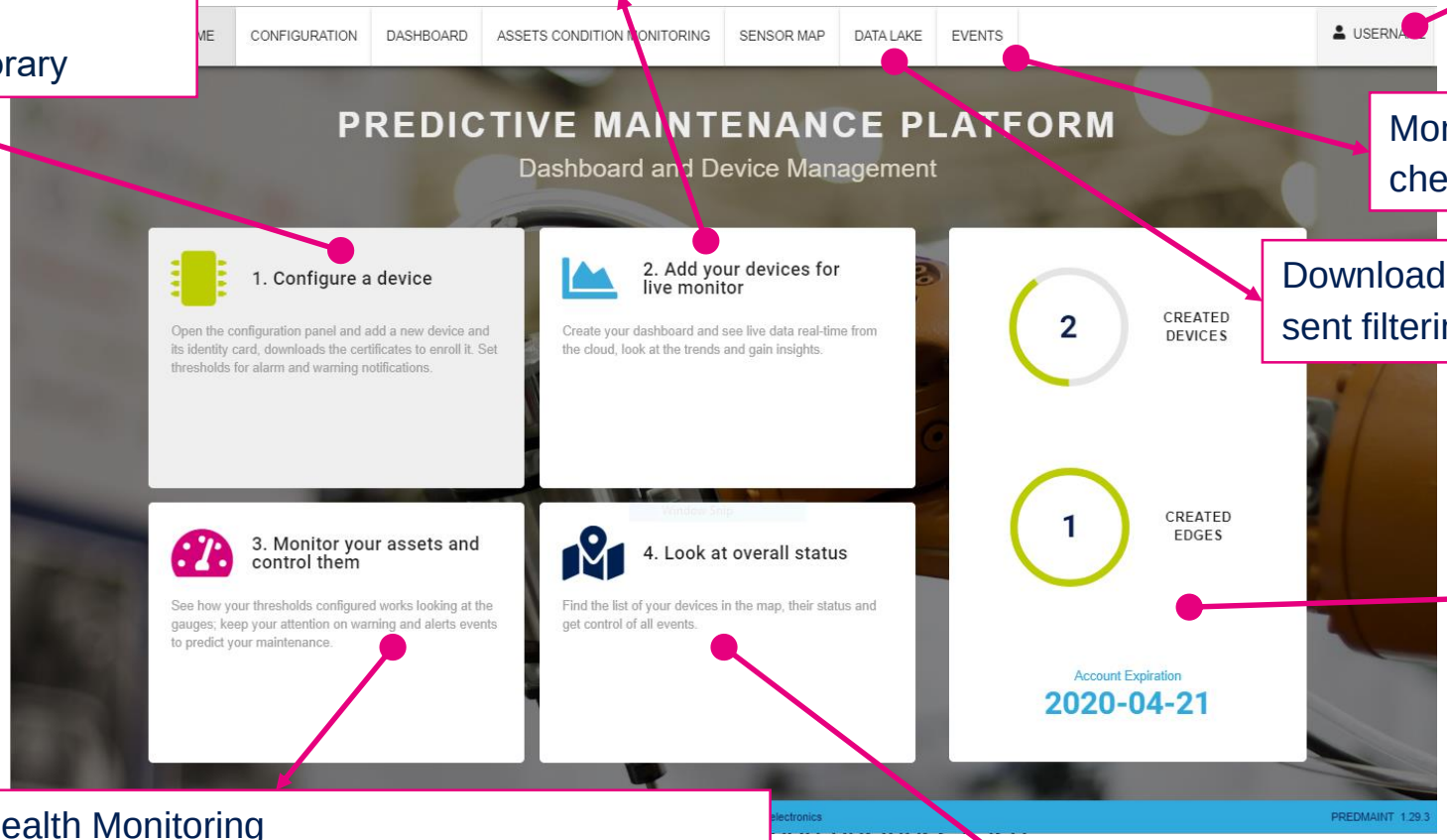
- Device and AWS Greengrass Edge registration and configuration:
  - Provisioning
  - Association to assets
  - Streaming time
  - NanoEdge™ AI library

- Live data visualization
  - Add a device to live monitoring

- User login and data segregation

Monitor live events or check events history

Download telemetry data sent filtering by device



- English and Chinese

Info Panel for the user about its terms

- Asset Health Monitoring
  - Collect data
  - Analyse Historical trends
  - Apply failure thresholds for alerts and warning

- Assets Map

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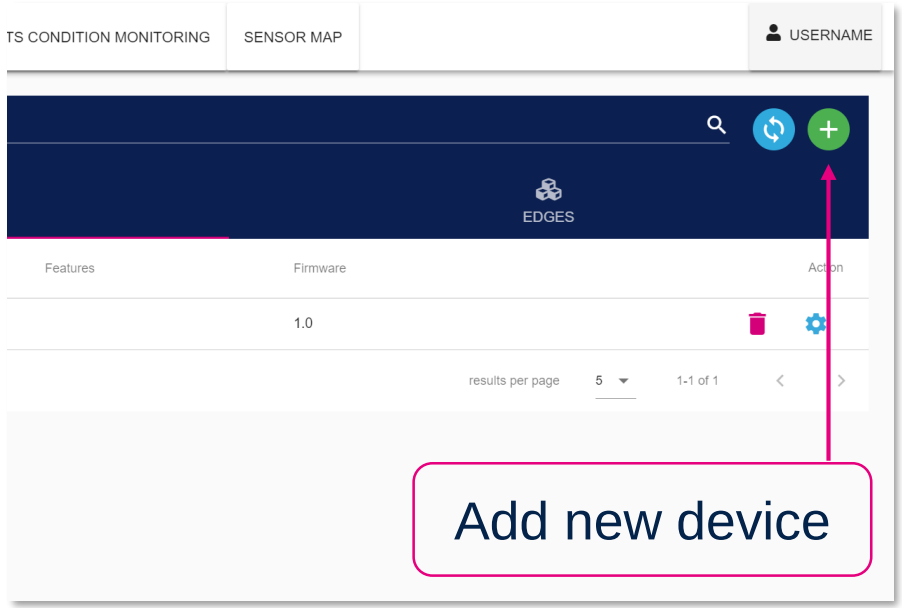
Predictive Maintenance Dashboard

Register, add, remove and manage a device

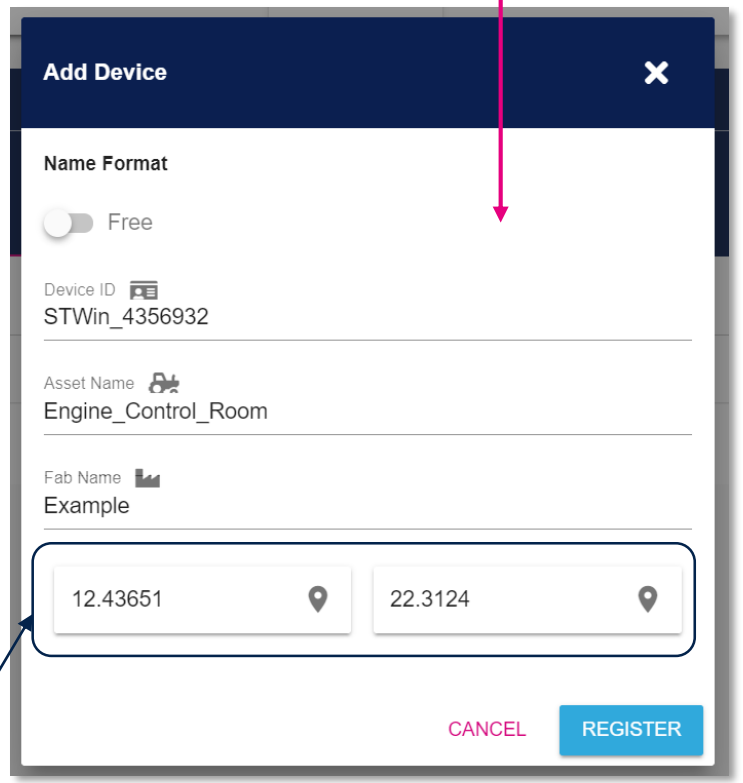
1



Add new device

2

Compile form



Latitudes and longitudes coordinates

3

Download device certificate and take note of IoT endpoint

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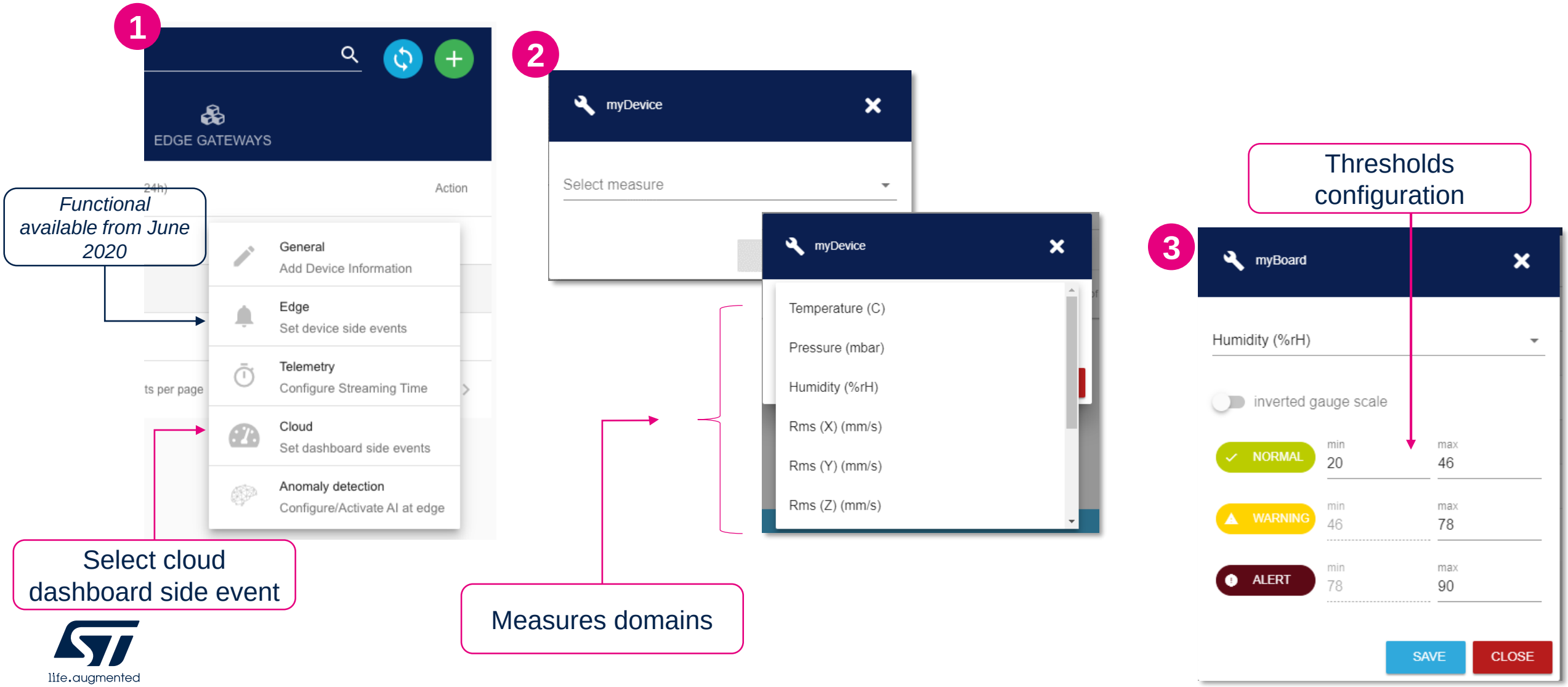
Predictive Maintenance Dashboard

Configure measures and condition monitoring thresholds



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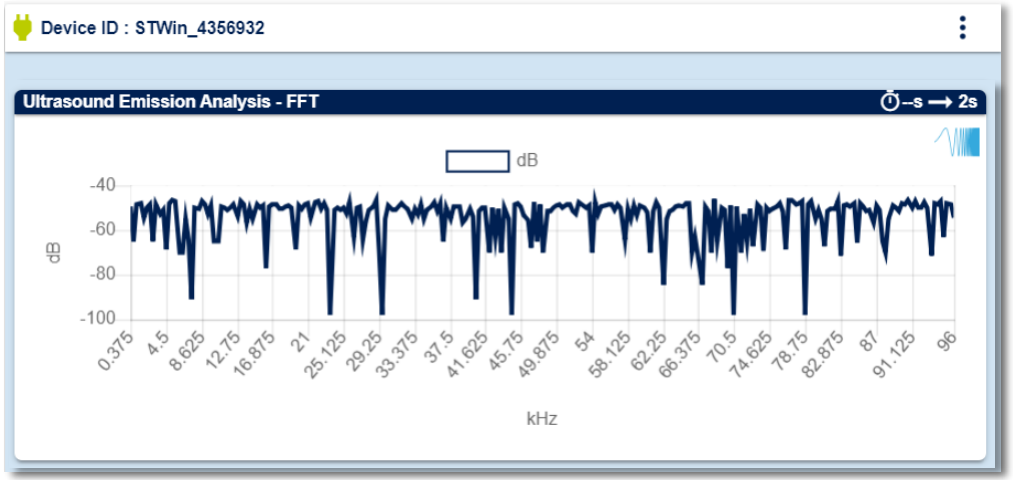
Predictive Maintenance Dashboard

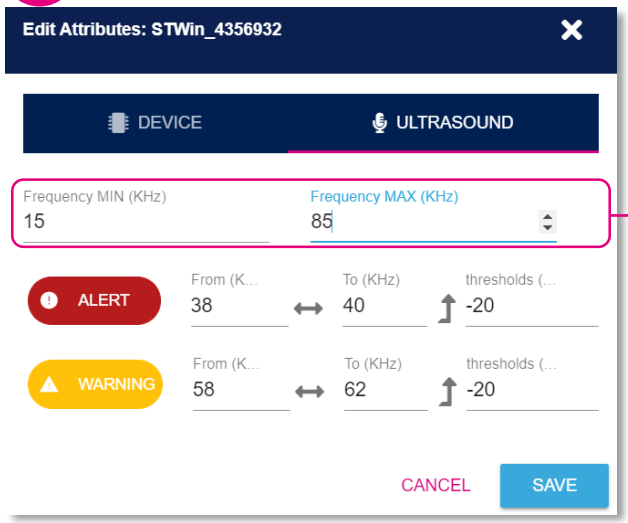
Set Ultrasound FFT filter

1

No filters

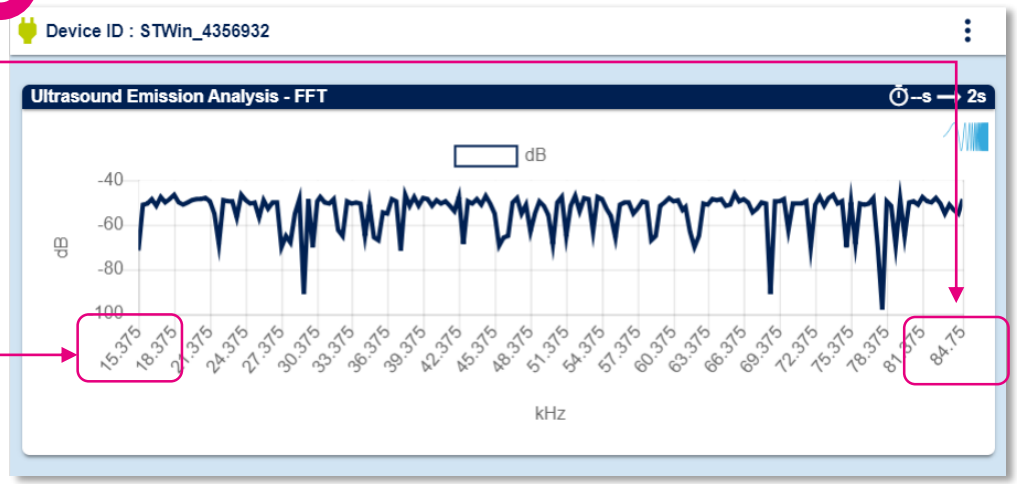


2



Applying filters

3



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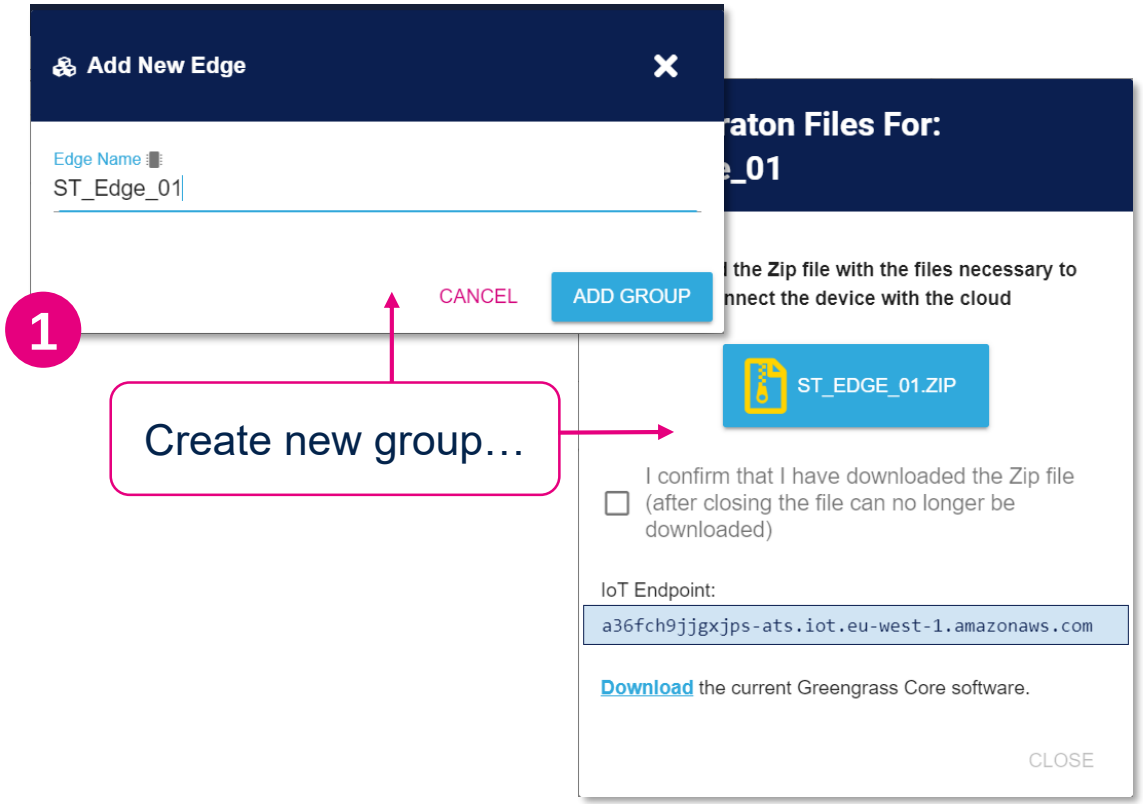
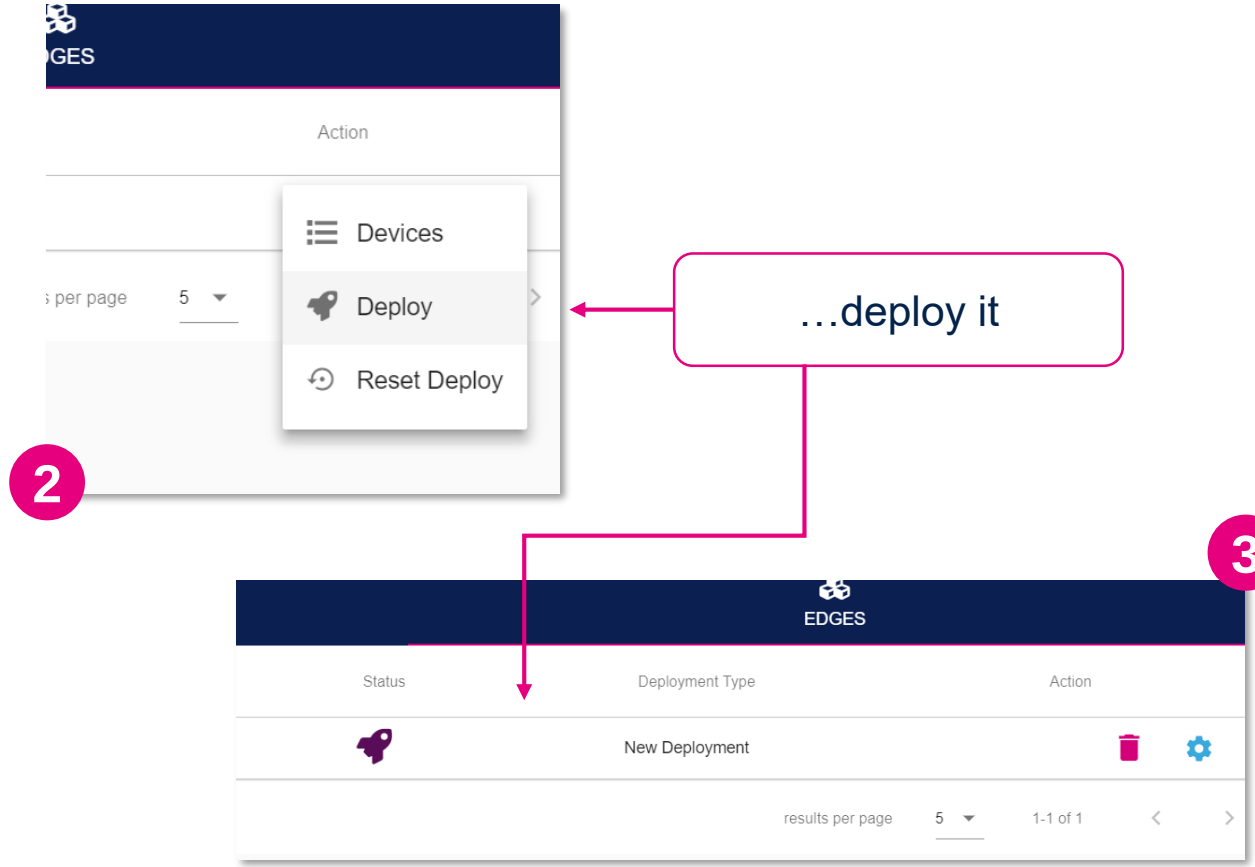
Predictive Maintenance Dashboard

Register and manage an AWS Greengrass Group





Predictive Maintenance Dashboard
Hand Shaking Device - Cloud

The device, once connected for the first time, generates a *Hand Shaking Message* used to expose the measures (environmental, vibration, ultrasound) and Firmware Release

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Predictive Maintenance Dashboard
Hand Shaking Device – Flexible visualization

Environmental domain

Vibration (FFT) domain

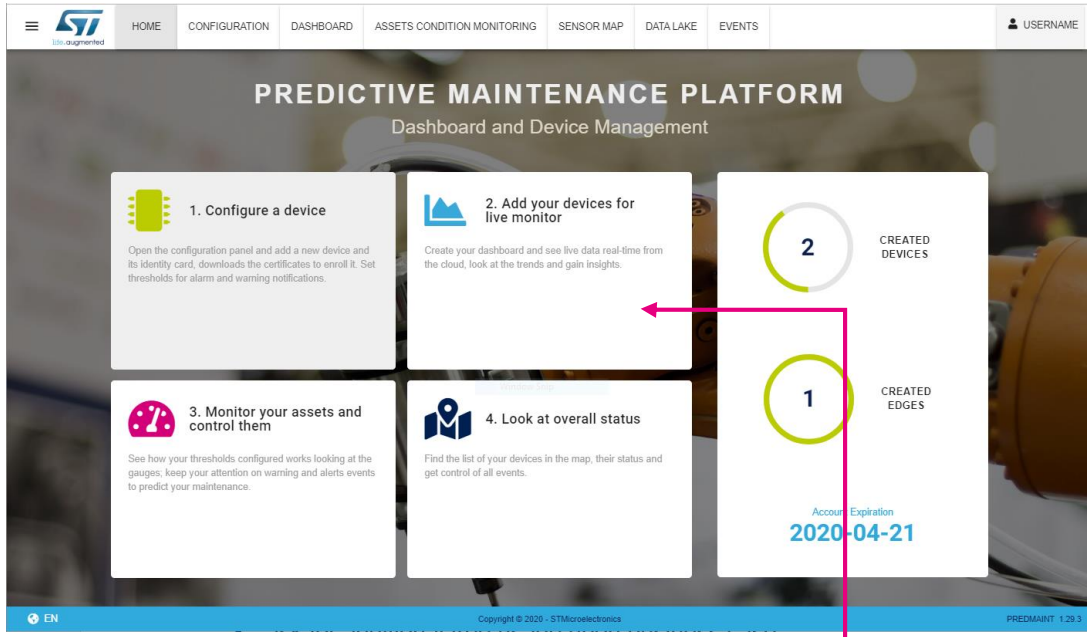
Vibration Analysis: TD & FD results

Acoustic (FFT) domain

The Dashboard recognizes the device, update the device shadow (that will be used for other purposes also) and adapt the visualization

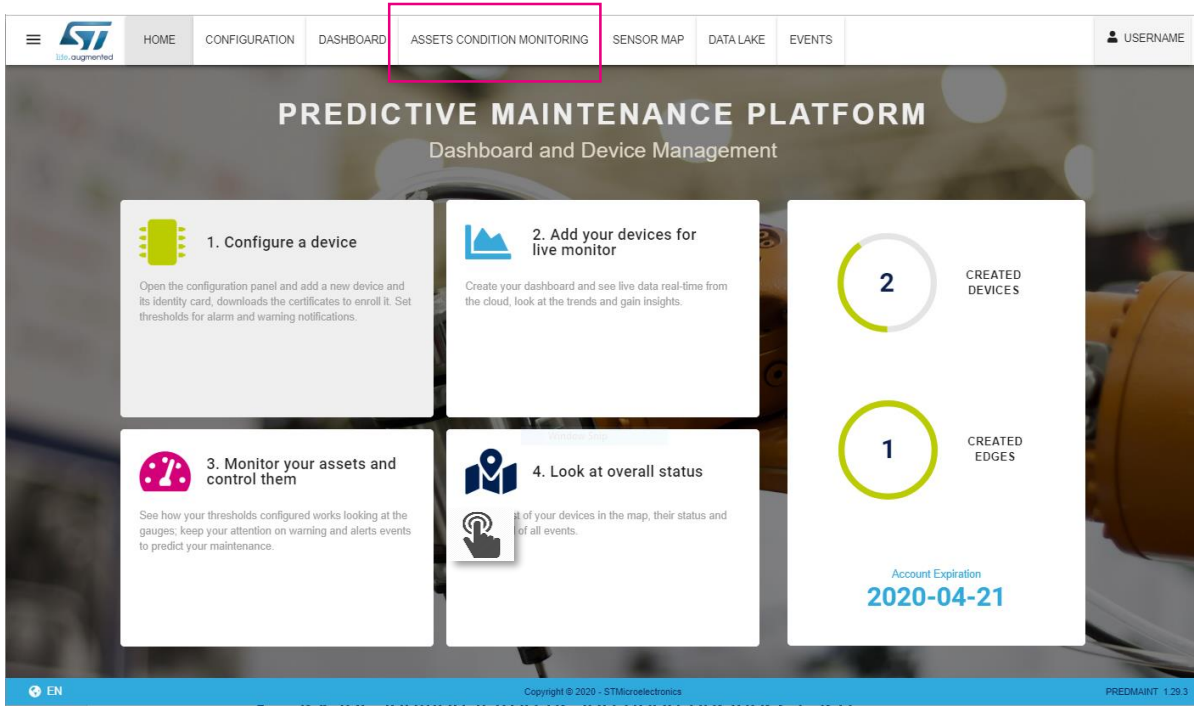
Predictive Maintenance Dashboard

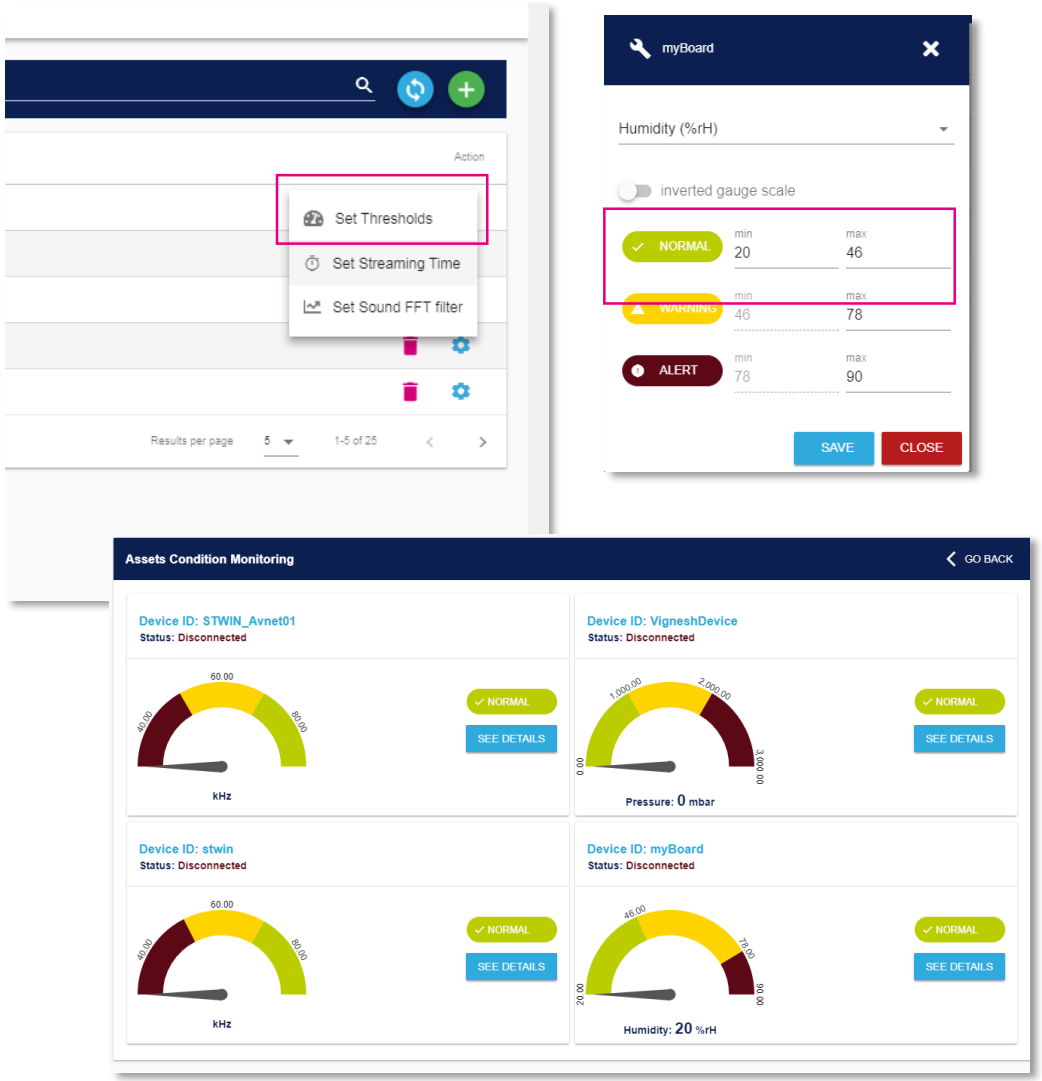
Add a device to live monitoring



Select your device for live monitoring

Predictive Maintenance Dashboard
Assets Monitoring





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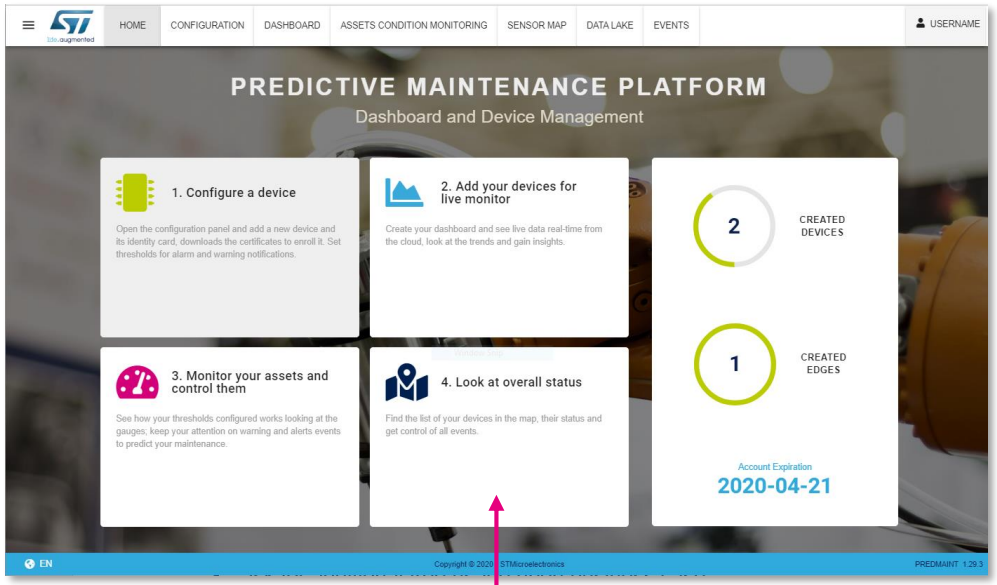
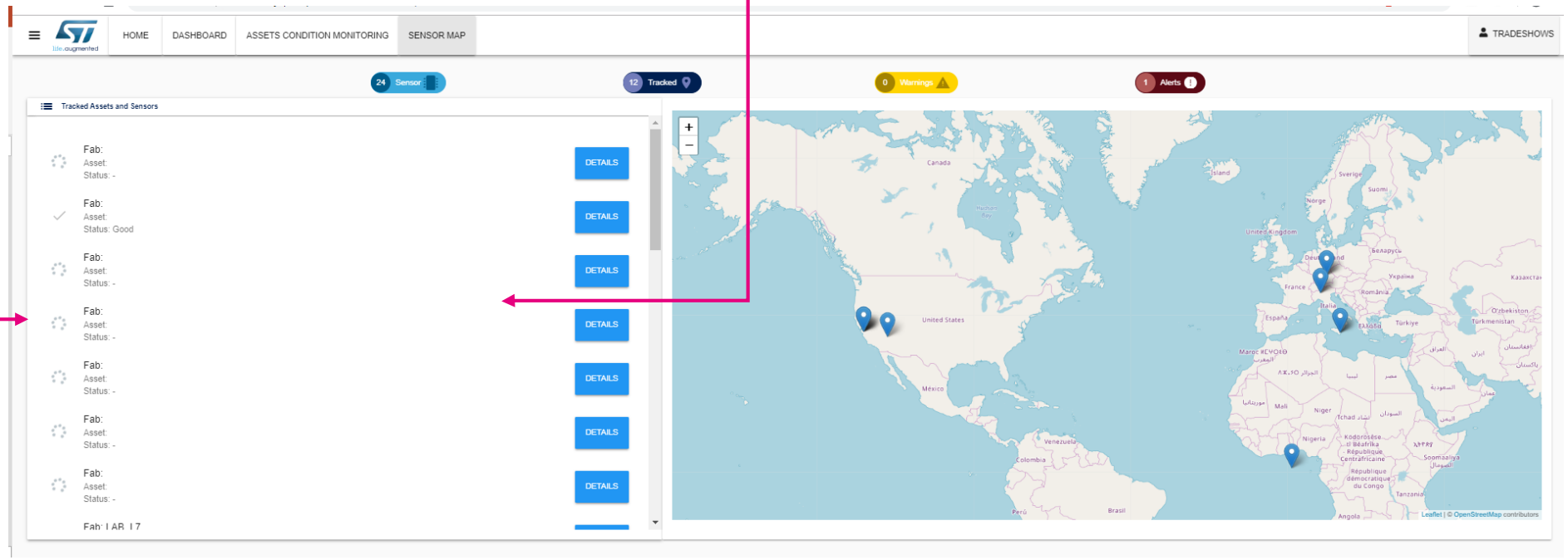
Predictive Maintenance Dashboard

Assets Map



Assets and Status

Geo-localization



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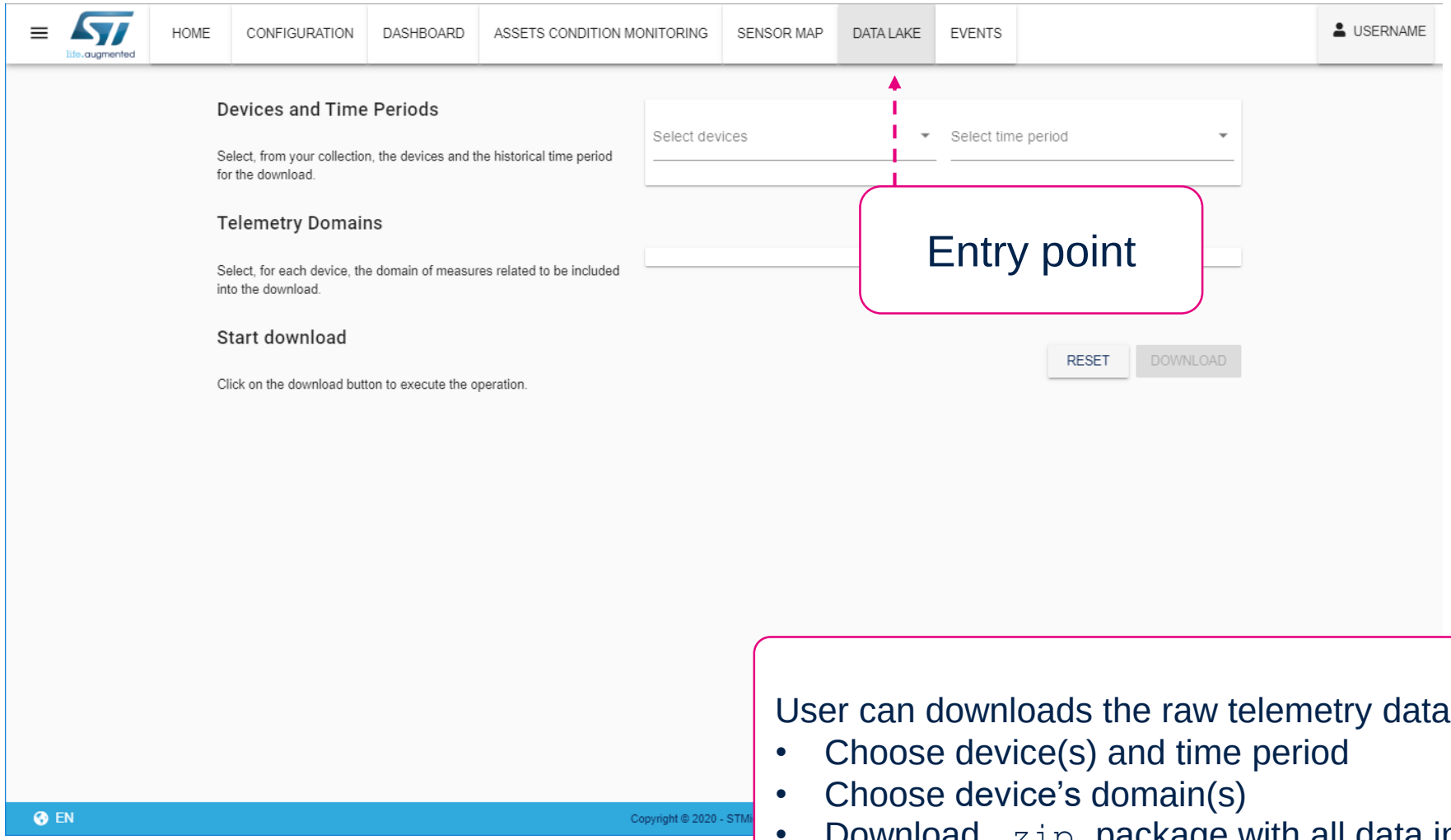
Predictive Maintenance Dashboard
Data Download



User can downloads the raw telemetry data for his devices

- Choose device(s) and time period
- Choose device's domain(s)
- Download `.zip` package with all data in.

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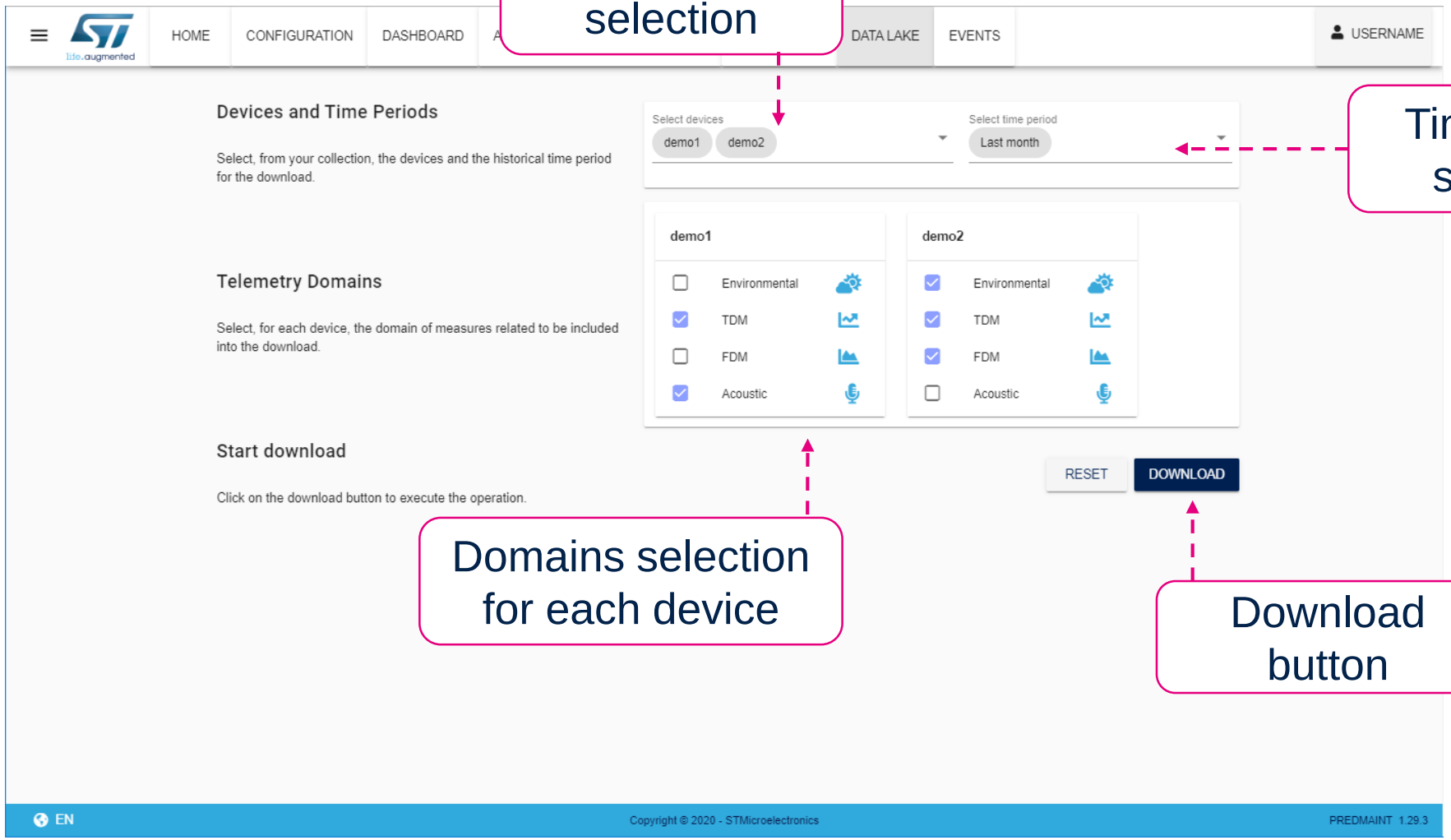
Predictive Maintenance Dashboard
Data Download



Devices selection

Time period selection

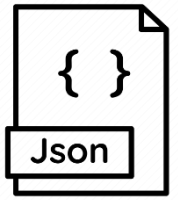
Domains selection for each device

Download button

Predictive Maintenance Dashboard
Data Download

Folder structure downloaded

```
user-id
    device-name
        domains
        …
        …
            year
                month
                    weeknum.json
```

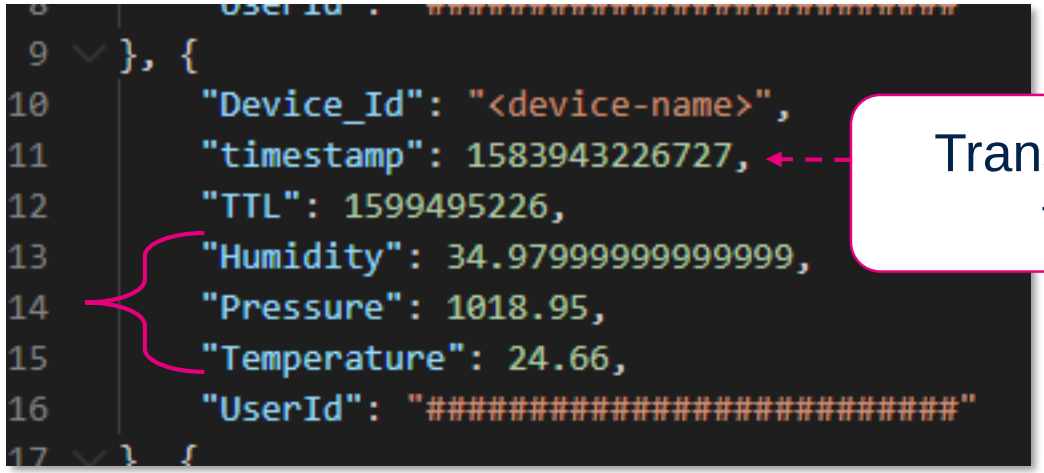


Aggregated (by week) `json` file containing all data for the relative domain

```
[{
    "Device_Id": "<device-name>",
    "timestamp": 1583943221725,
    "TTL": 1599495221,
    "Humidity": 34.97,
    "Pressure": 1018.92,
    "Temperature": 24.66,
    "UserId": "##########################"
}, {
    "Device_Id": "<device-name>",
    "timestamp": 1583943226727,
    "TTL": 1599495226,
    "Humidity": 34.97999999999999,
    "Pressure": 1018.95,
    "Temperature": 24.66,
    "UserId": "##########################"
}, {
    "Device_Id": "<device-name>",
    "timestamp": 1583943231727,
    "TTL": 1599495231,
    "Humidity": 34.90999999999999,
    "Pressure": 1018.91,
    "Temperature": 24.6,
    "UserId": "##########################"
}]
```

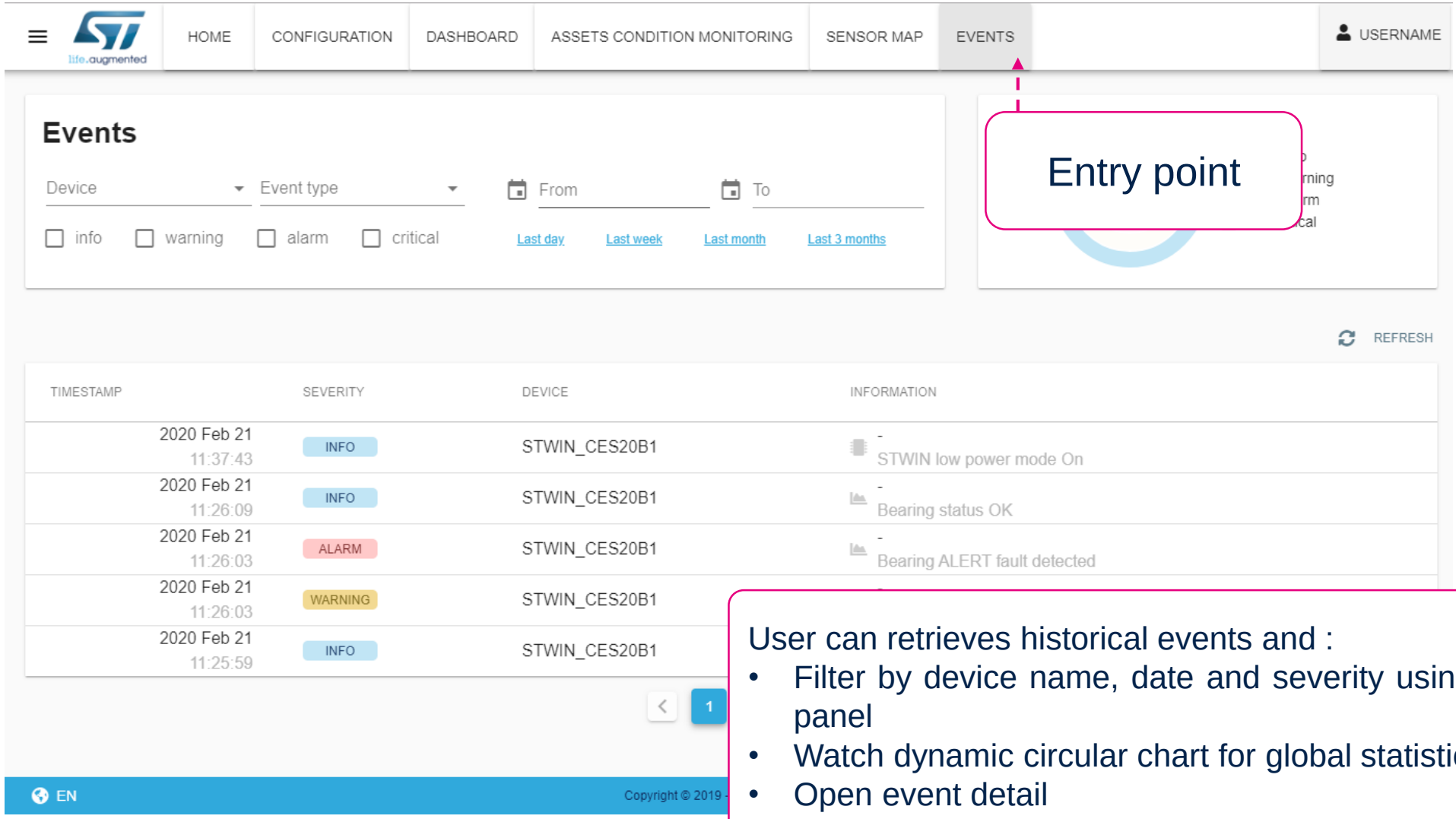
Predictive Maintenance Dashboard
Data Download

Telemetry data (environmental)



Transmission time

Predictive Maintenance Dashboard
Events



User can retrieves historical events and :

- Filter by device name, date and severity using advanced panel
- Watch dynamic circular chart for global statistics
- Open event detail

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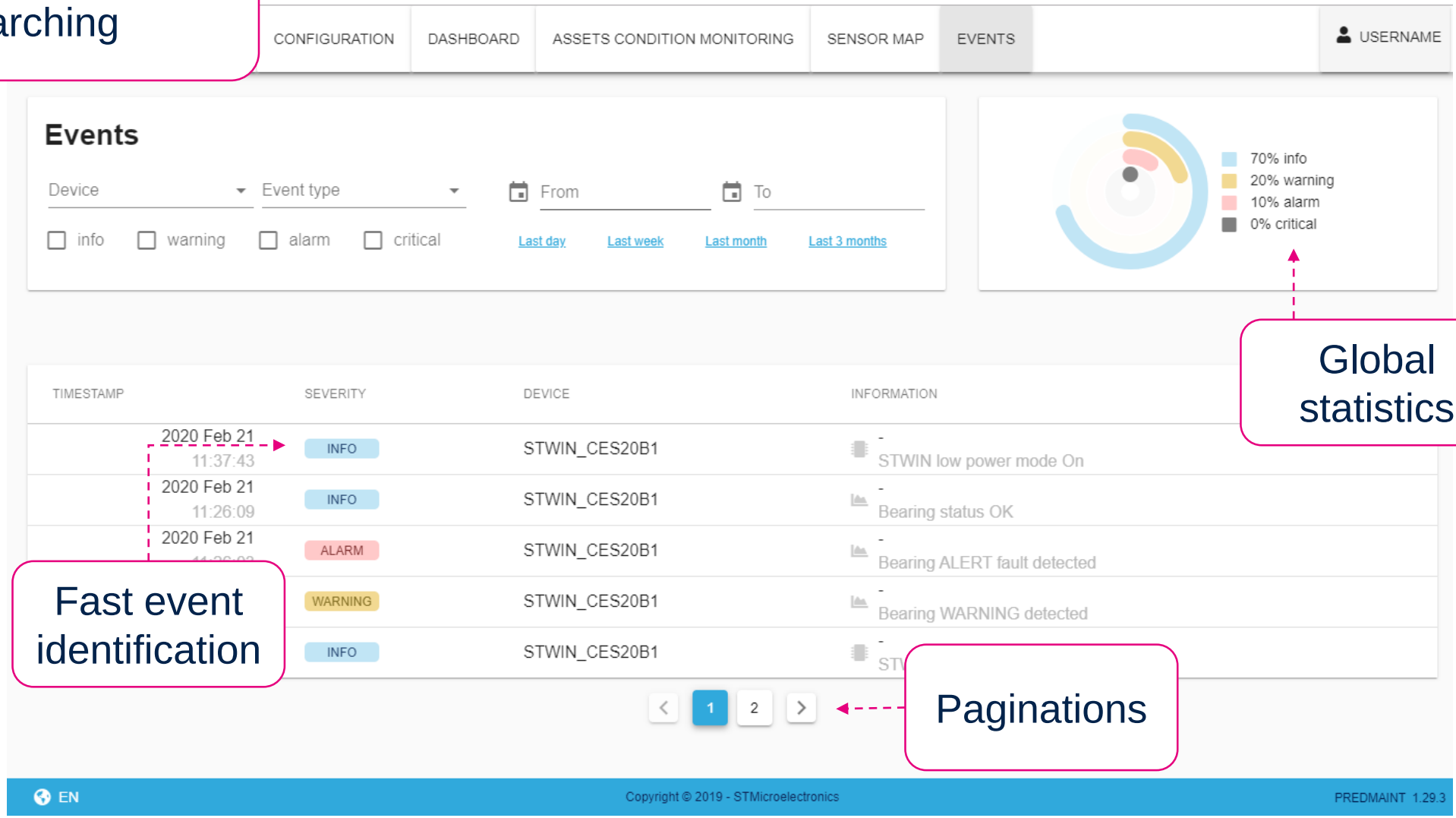
Predictive Maintenance Dashboard
Events

Filters for advanced searching



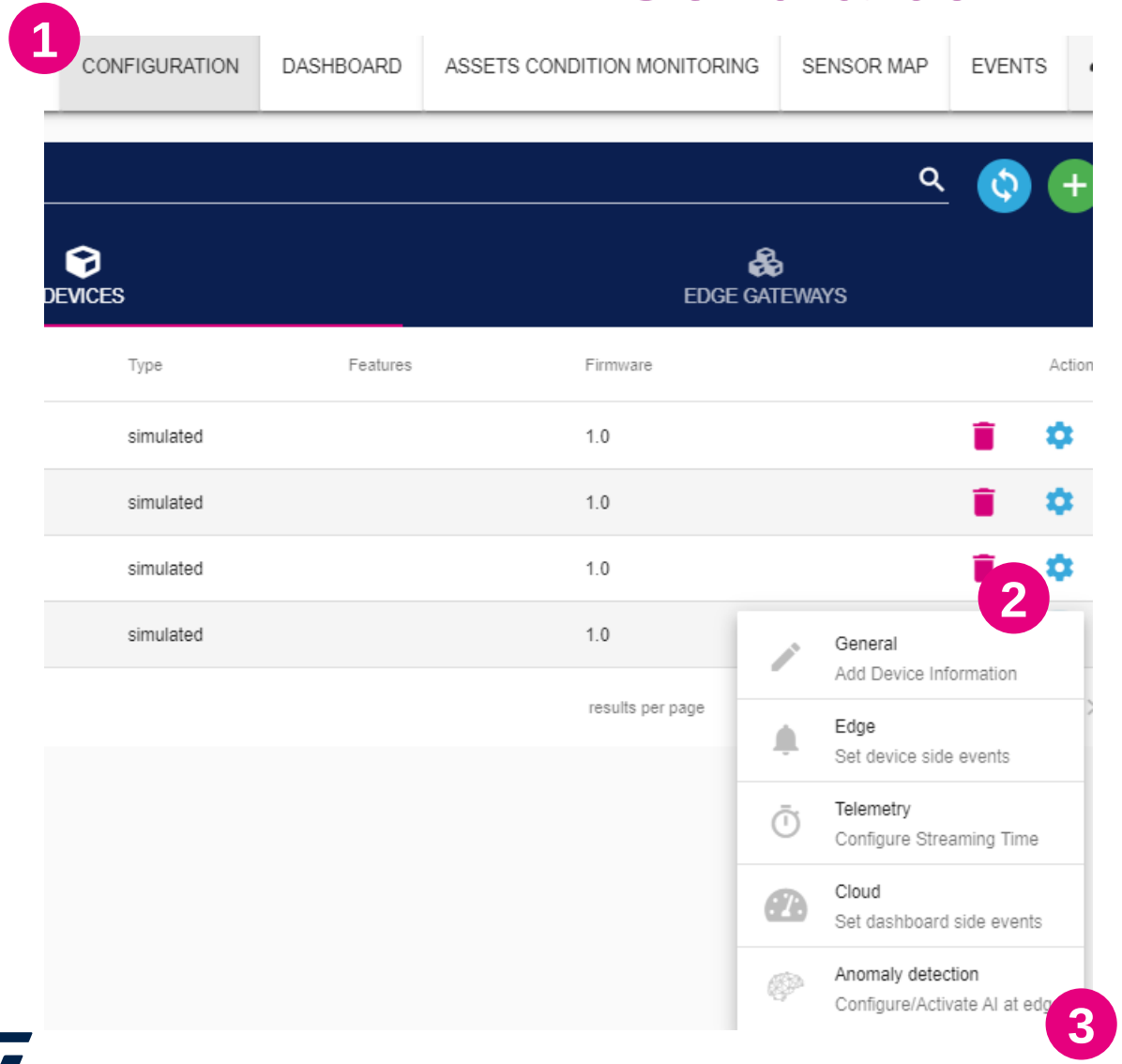
Global statistics

Fast event identification

Paginations

This feature will be functional available from June 2020

Predictive Maintenance Dashboard
Send a command to NanoEdge™ AI library



- DSH-PREDMNT allow you to configure and setup your custom NanoEdge™ AI library

1. Click on the **Configuration** tab
2. Select the **()** symbol of the desired STWIN board
3. Click on **Anomaly detection**

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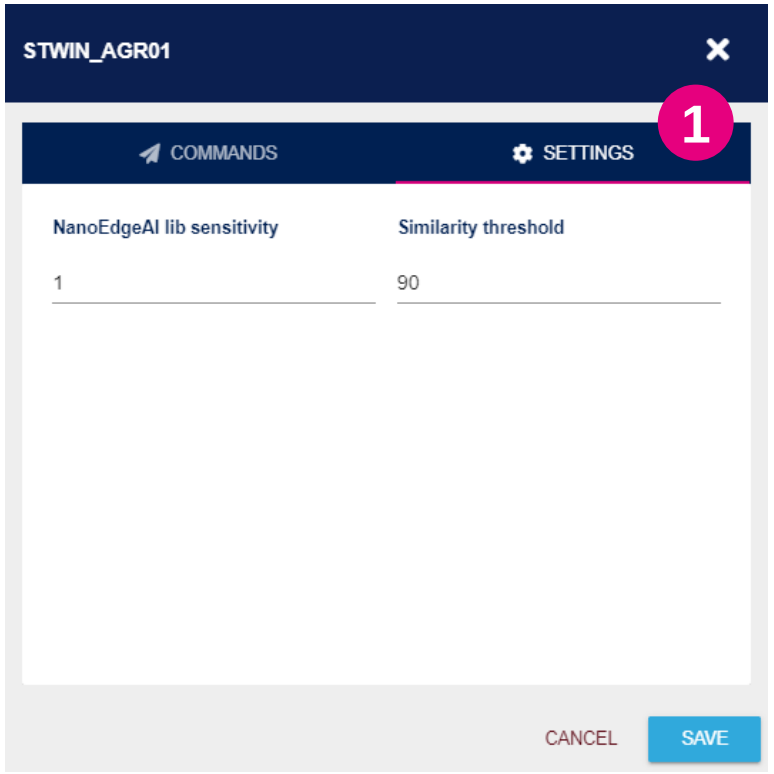
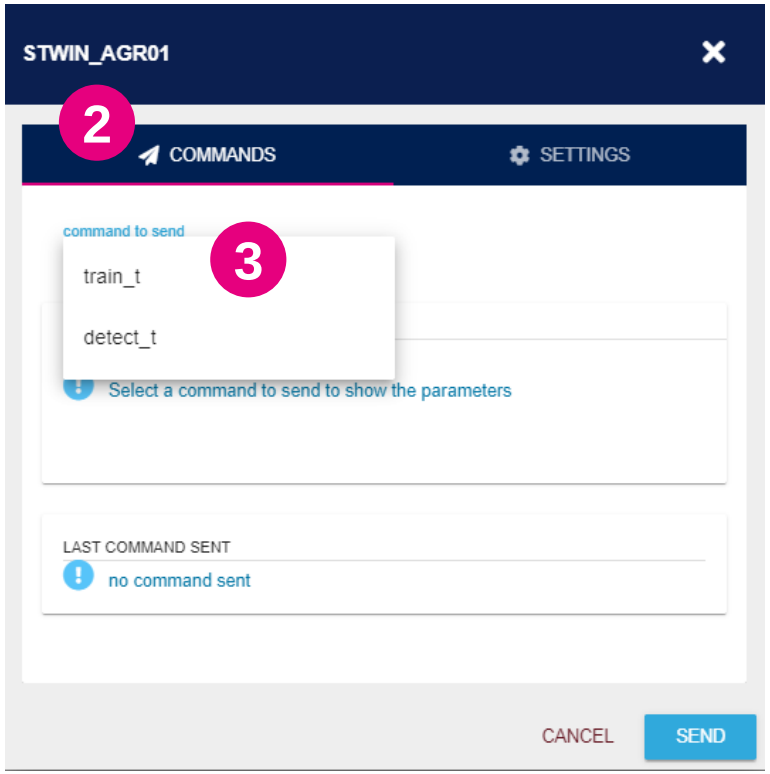
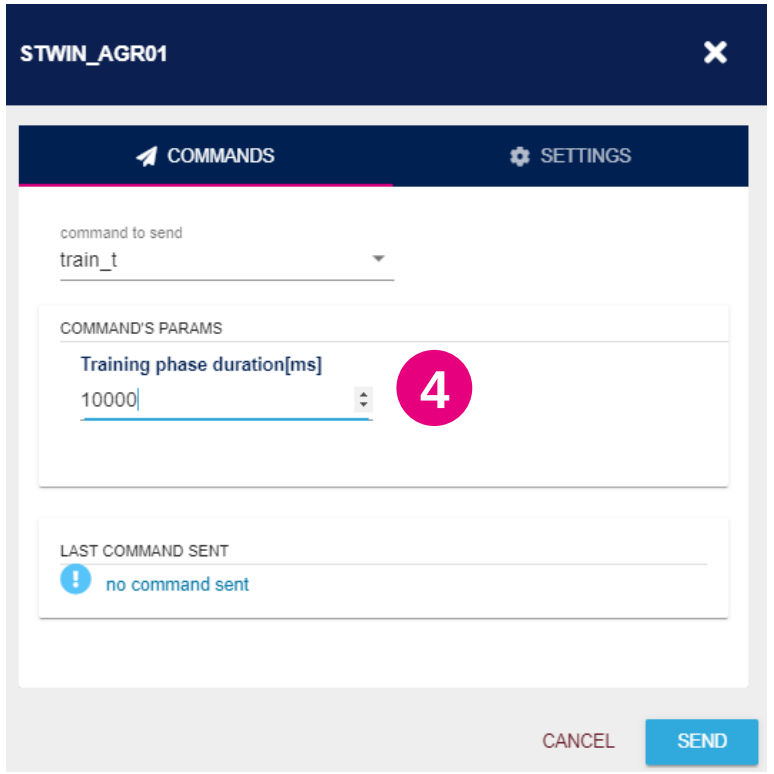
Predictive Maintenance Dashboard
Send a command to NanoEdge™ AI library







- The **settings** tab allow to setup the sensitivity and the threshold parameters
- The **commands** tab allow to chose either train or detect command. The result of the train command is the training of the neai library for the time interval set in the “phase duration” form. The detect command will trigger the anomaly detection phase in the application in according with the generated library

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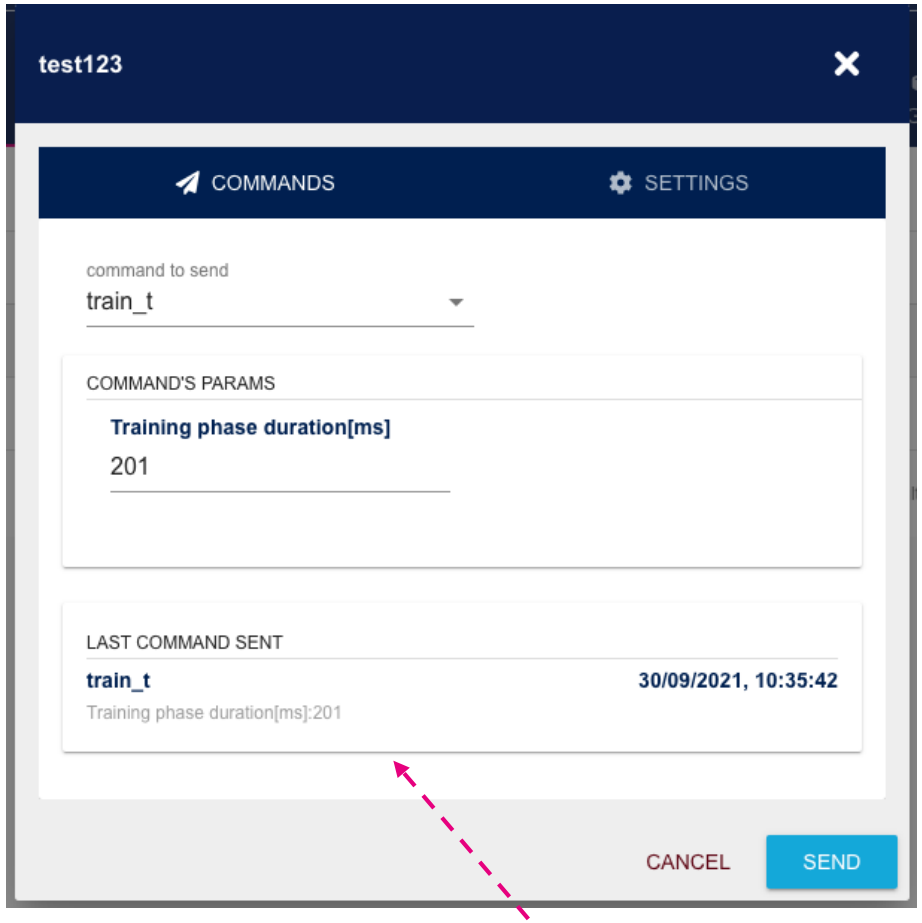
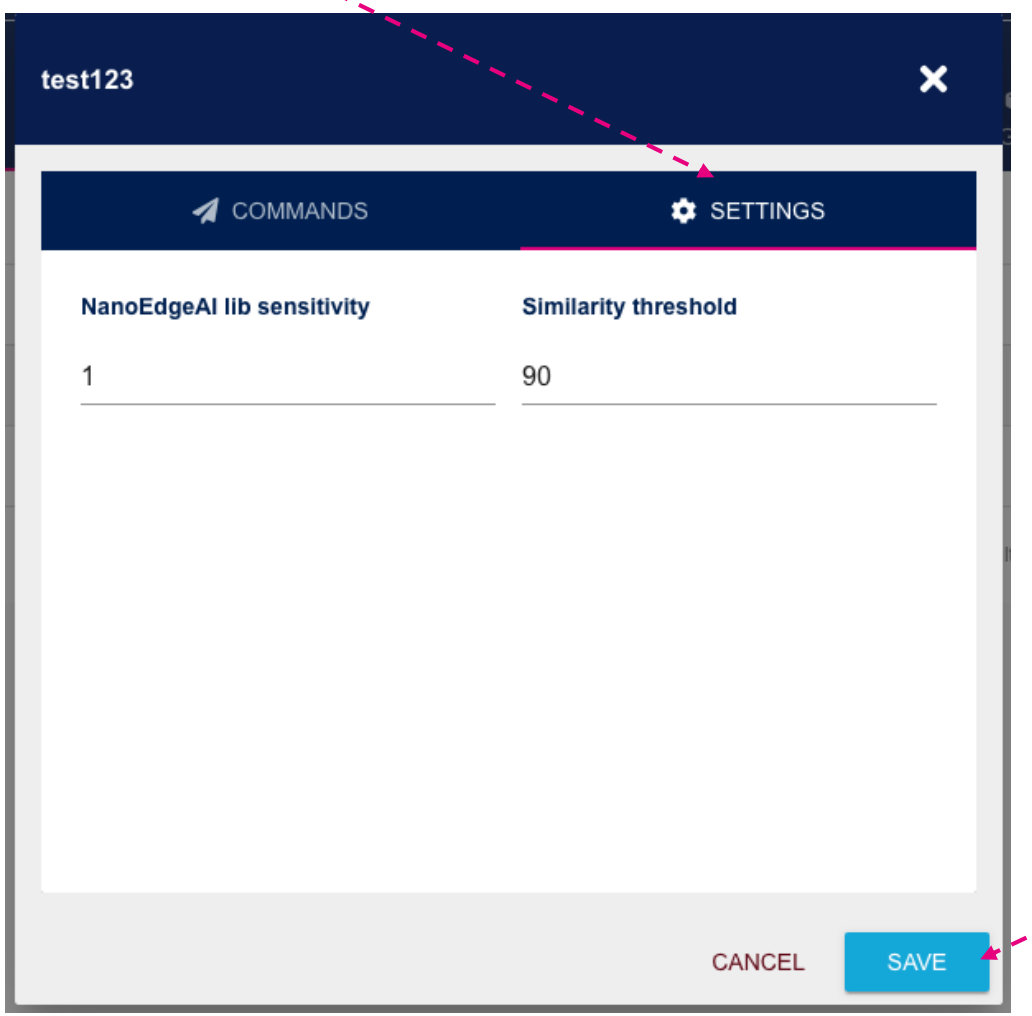
Predictive Maintenance Dashboard

Send a command to NanoEdge™ AI library



See the information about the last command sent

Use settings tab to change configuration parameters



Save parameters on the device

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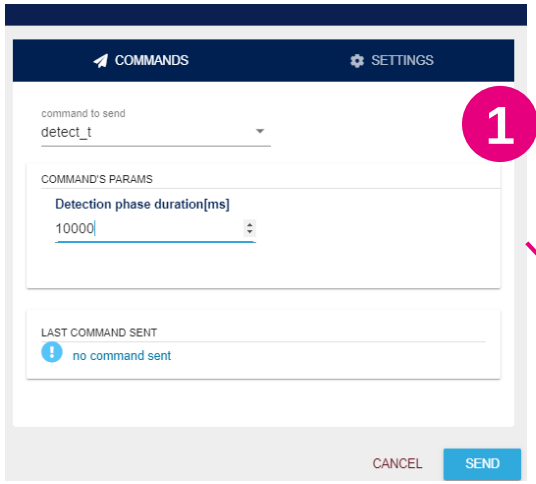
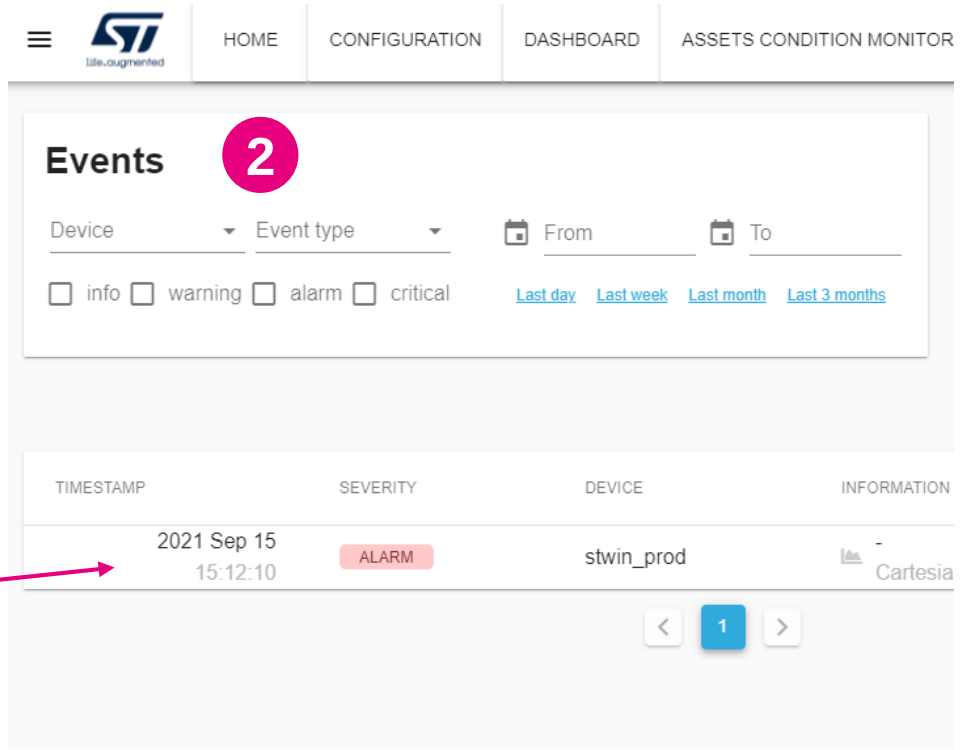
Detection phase of NanoEdge™ AI library



Start detection

Orange led is blinking

Alarm sent



- If the detect command is set, in according with the custom NanoEdge™ AI library, an anomaly event is sent to the dashboard and an event will be shown in the EVENTS panel of the dashboard.
- For further details on how NanoEdge™ AI libraries work, read the detailed documentation of NanoEdge™ AI Studio.

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CONDITION MONITORING
Get started with SL-PREDMNT-E2C

Predictive Maintenance Dashboard
how to start

- Google Chrome
- ST Evaluation Tools and SW Packages on your hand, you can combine both approach as you may need

Quick start

End to end architecture based on wired Smart Sensor Nodes and Gateway

STM32MP157C-DK2 rev. C01
X-LINUX-PREDMNT

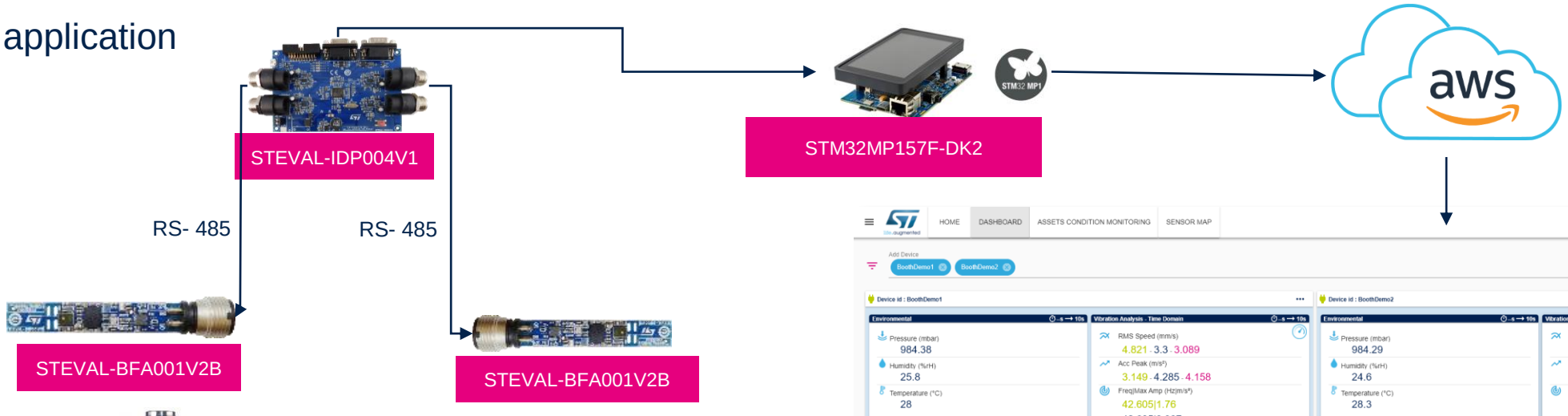
STEVAL-IDP004V1/V2
STSW-IDP4PREDMNT

STEVAL-BFA001V1B
STSW-BFA001V1B

Vibration and Environmental Monitoring
Quick Start with STM32MP157-DK2

In this scenario, two motors are monitored by using two STEVAL-BFA001V1B provisioned as BoothDemo1 and BoothDemo 2 connected via a Master STEVAL-IDP004V1 and a Gateway STM32MP157C-DK2 rev. C01 connected over WIFI. One of the motor is unbalanced (corresponding to BoothDemo2).

1. Get STEVAL-BFA001V1, STEVAL-IDP004V1, STM32MP157C-DK2 and Download the Software
2. Deploy the X-LINUX-PREMDNT on the STM32MP157C-DK2
3. Register the Edge and the devices
4. Start the application



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Vibration and Environmental Monitoring
Get the Hardware's, Download the SW

Go to www.st.com/SL-PREDMNT-E2C

Buy the Hardware

Component	Order code	Description
Smart Sensor Node	STEVAL-BFA001V2B	Predictive maintenance kit with sensors and IO-Link capability
Master	STEVAL-IDP004V1 STEVAL-IDP004V2	IO-Link master multi-port evaluation board
Gateway	STM32MP157F-DK2	Discovery kit with STM32MP157C MPU

Download all the SW

SW Layer Mission	Software Code	Distribution
Collect, Preprocess and communicate to the Master	STSW-BFA2PREDMNT.zip	Binary
Handle the communication with the Smart Sensor Node and with the gateway	STSW-IDP4PREMNT.zip	Binary
Handle the communication with the master, enable Edge processing and data injection in the Cloud	X-LINUX-PREDMNT	OpenSTLinux Expansion Pack in Source Code and with SD Card image
Visualize data	DSH-PREDMNT	

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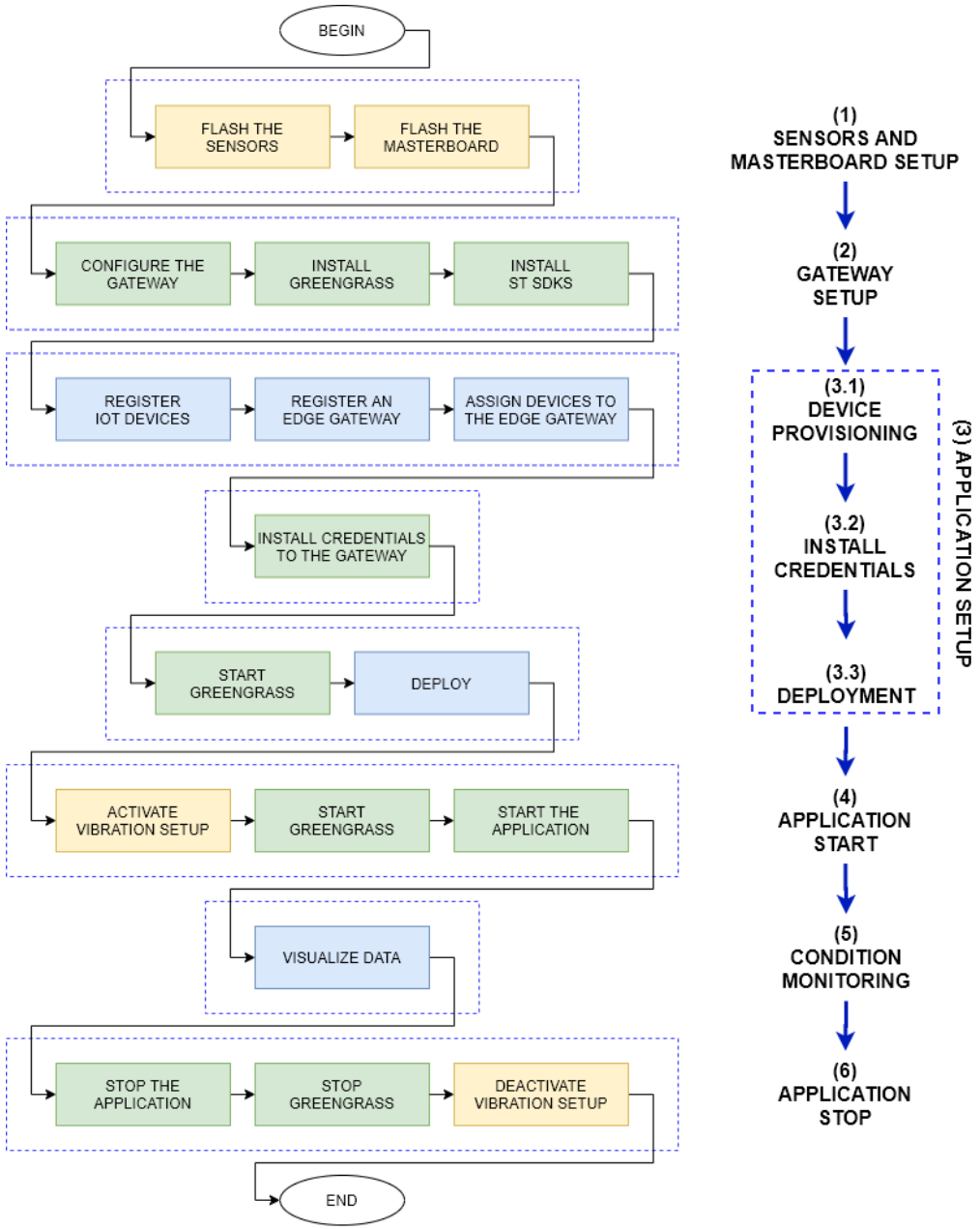
Vibration Monitoring
deploy X-LINUX-PREDMNT



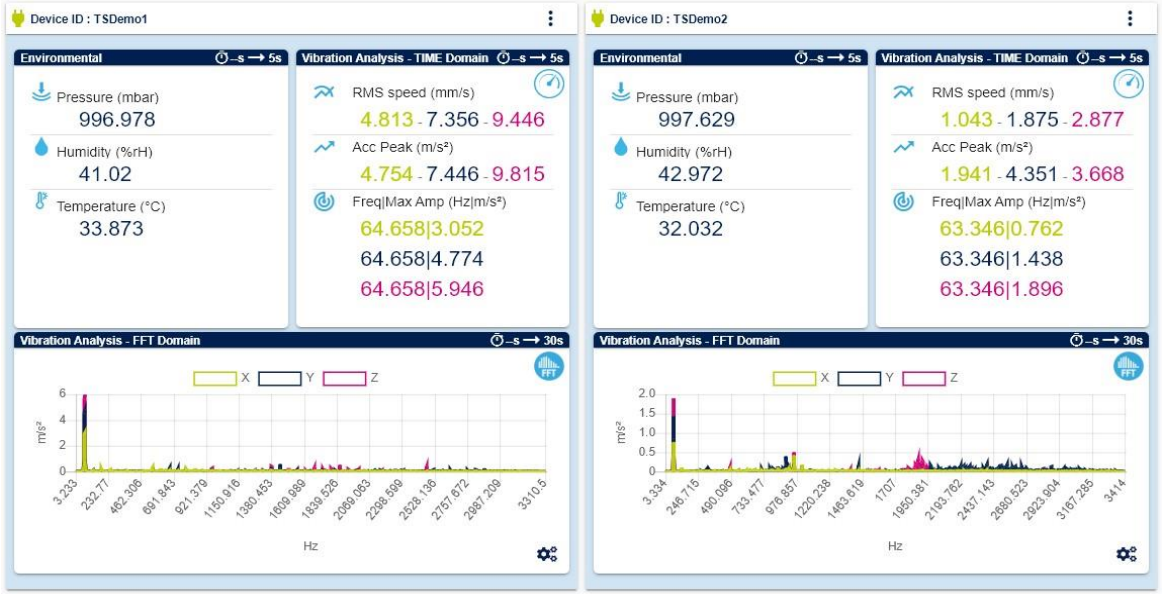
Go to https://www.st.com/content/st_com/en/products/evaluation-tools/solution-evaluation-tools/process-control-and-automation-solution-eval-boards/sl-predmnt-e2c.html

Vibration and Environmental Monitoring
Start the application

You can start the application after the configuration and deployment phases.

Follow the procedure below to activate vibration and start the application on your setup with or without motors.

1. Connect the setup to the gateway via USB cable.
2. If you connect rotating motors, power on the setup.
3. Set the speed of the setup to the desired value.
4. Click “RUN APPLICATION” on the gateway GUI, or run “/home/root/start_pmp.sh” from a terminal:



Open the dashboard and log in: https://dsh-predmnt.st.com/

Click on [**DASHBOARD**]>[**Add Device**], and select the desired devices.

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CONDITION MONITORING
Get started with SL-PREDMNT-S2C

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Predictive Maintenance Dashboard
how to start

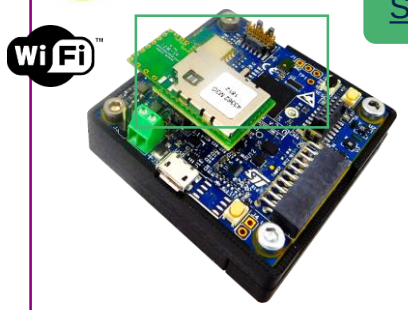
- ST Evaluation Tools and SW Packages on your hand, you can combine both approach as you may need
- Google Chrome, view directly in your browser the data coming thanks to DSH-PREDMNT application

Quick start

End to end architecture based on Wireless Smart Sensor Nodes (WIFI – LPWAN) – SL-PREDMNT-S2C

STM32 Open Development Environment

STEVAL-STWINWFV1



STEVAL-STWINKT1B

FP-IND-PREMNT1

STEVAL-STWINKT1B

NB-IoT

LTE-M

STMOD+ cellular add-on board coming from P-L496G-CELL02 or STEVAL-STMODLTE*

STSW-STWINCELL

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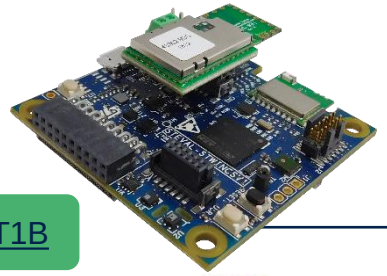
*Distributed only in USA

Vibration and Ultrasound Monitoring
Quick Start with WIFI expansion STEVAL-STWINWF1

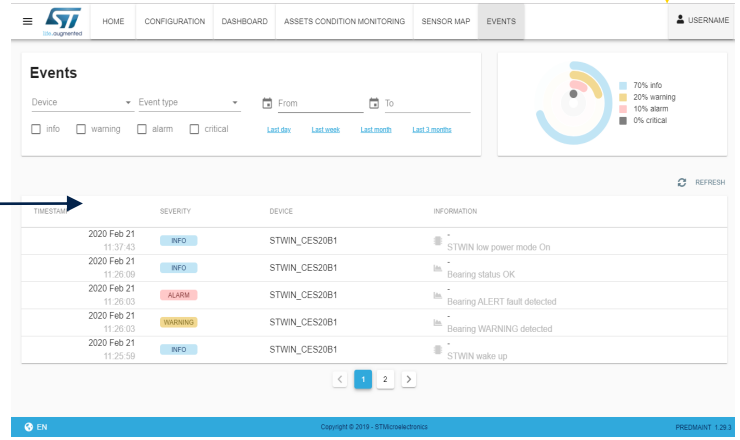
In this scenario a motor is monitored by using an STEVAL-STWINKT1B as smart sensor node connected by using the WIFI expansion module (STEVAL-STWINWFV1) and the smart sensor node is provisioned.

1. Get STEVAL-STWINKT1B and STEVAL-STWINFV1
2. Download the FP-IND-PREMNT1 and Flash it
3. Register your node at DSH-PREDMNT
4. Run the application
5. Monitor data on DSH-PREDMNT

STEVAL-STWINWFV1



STEVAL-STWINKT1B



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Vibration and Ultrasound Monitoring through WIFI

Get the Hardware, Download the Software

Buy the Hardware

Component	Order code	Description
SensorTile Wireless Industrial Node (STWIN)	STEVAL-STWINKT1B	Predictive maintenance kit with sensors
Expansion board	STEVAL-STWINWF1	WIFI Expansion

Get the Software

SW Layer Mission	Software Code	Online Distribution
Collect, Preprocess and communicate to the Cloud	FP-IND-PREDMNT	Source code available for STM32
Visualize data	DSH-PREDMNT	Web based application

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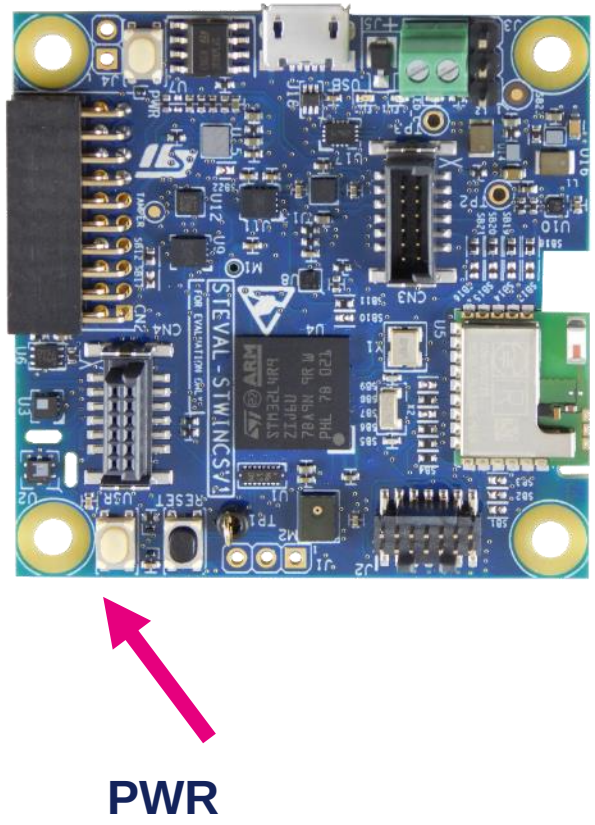
Power ON/OFF the STWIN

- Battery only (no USB cable):
  - Power ON
    - Long-press the PWR button until the red led turns off (~1 sec)
  - Power OFF
    - Press the PWR button
- Plugged mode (USB cable)
  - Power ON
    - When USB is plugged-in, the STWIN is always on. It doesn’t matter if the battery is present or not
  - Power OFF
    - Unplug the cable and, if the battery is connected, press the PWR button.



Download FP-IND-PREDMNT1 and Flash
Predictive Maintenance Cloud Application (1/5)

www.st.com/stm32ode-fp

1

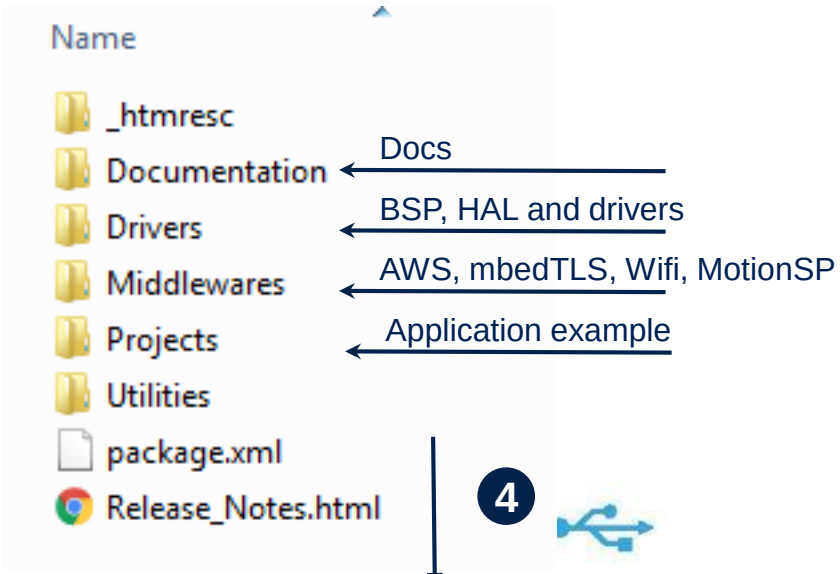
2

Select
FP-IND-PREDMNT1

3

Download & unpack

FP-IND-PREDMNT1 package structure



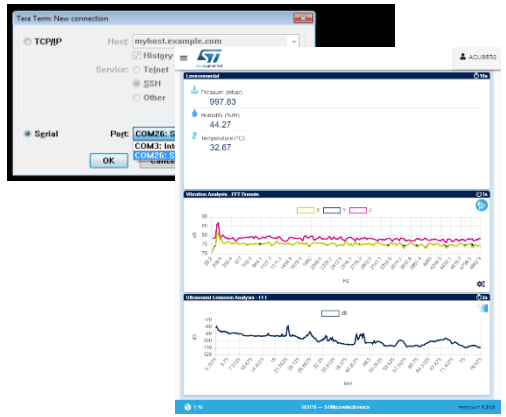
4

5

Compile/Flash and Run the project


.\Projects\STM32L4R9ZI-STWIN\Demonstrations\Predictive_Maintenance_WIFI\AWS\
OR
Load the pre-compiled binary using STM32 ST-LINK Utility

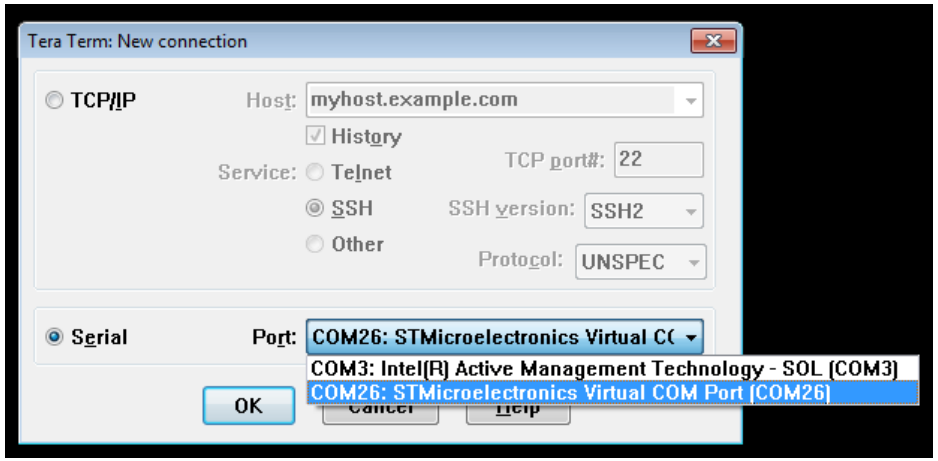
6 Configure and Monitoring the application
- TeraTerm (v. 4.97 or higher)
- ST DSH-PREDMNT

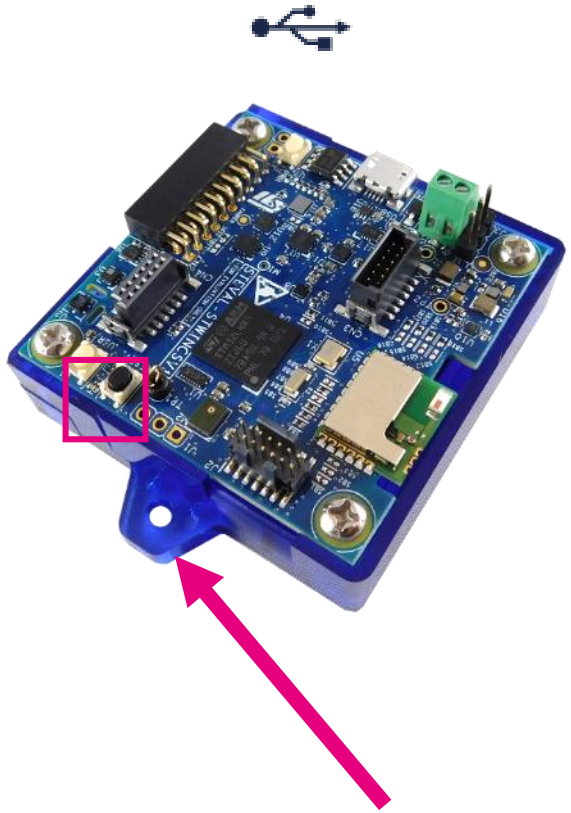


.\Projects\STM32L4R9ZI-STWIN\Demonstrations\Predictive_Maintenance_WIFI/AWS\Binary\STM32L4R9ZI-STWIN_PredictiveMaintenance_WIFI_v2.0.0.bin

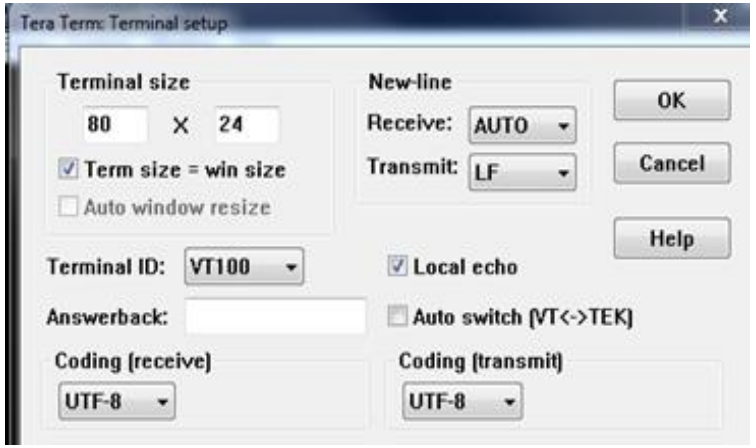
Set up your network configuration
Predictive Maintenance Cloud Application (2/5)

- Connect STWIN to the PC using a micro-USB cable
- Open TeraTerm (v. 4.97 or higher)
- File-> NewConnection
  - Select the right COM port





- Setup->Terminal
  - Set parameters as below



- Press RESET button of STWIN.

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Set up your network configuration
Predictive Maintenance Cloud Application (3/5)

To change Wi-Fi network follow the instructions on the console:

- Press the STWIN USR button within 5 seconds

```
Push the User button (B3) within the next 5 seconds if you want to update the Wi
Fi network configuration.

Your WiFi parameters need to be entered to proceed.

Enter SSID:
```

- Provide new Wi-Fi credentials:
  - SSID
  - Security mode
  - Password

```
Push the User button (B3) within the next 5 seconds if you want to update the Wi
Fi network configuration.

Your WiFi parameters need to be entered to proceed.

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

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

Enter password: fjfjfjf
```

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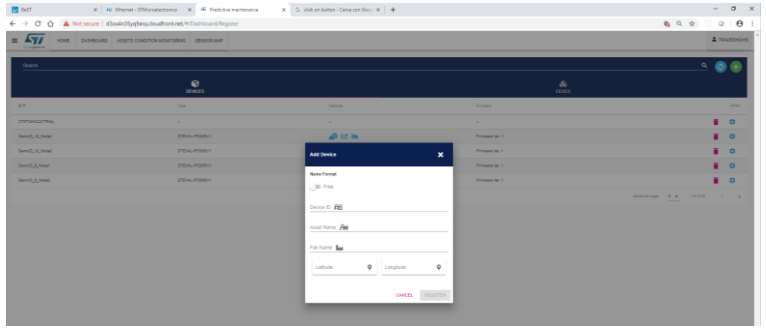
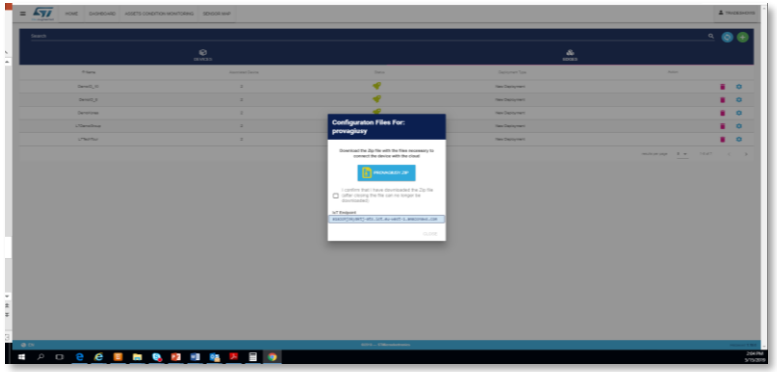
Register your node and inject data
Predictive Maintenance Cloud Application (4/5)

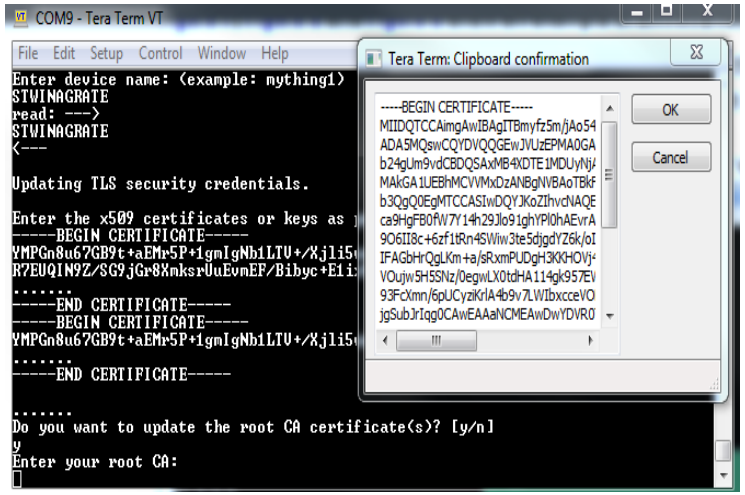
1 Register and provision the device by downloading the certificates





2 Configure AWS Credentials and load the certificates

- Press the USR button within 5 seconds
- Enter the AWS IoT Core endpoint
  - a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com (example for Predictive Maintenance Dashboard)
- Send via terminal the certificates obtained from the dashboard when the device was created:
  - Directly drag and drop the file or copy and paste the text



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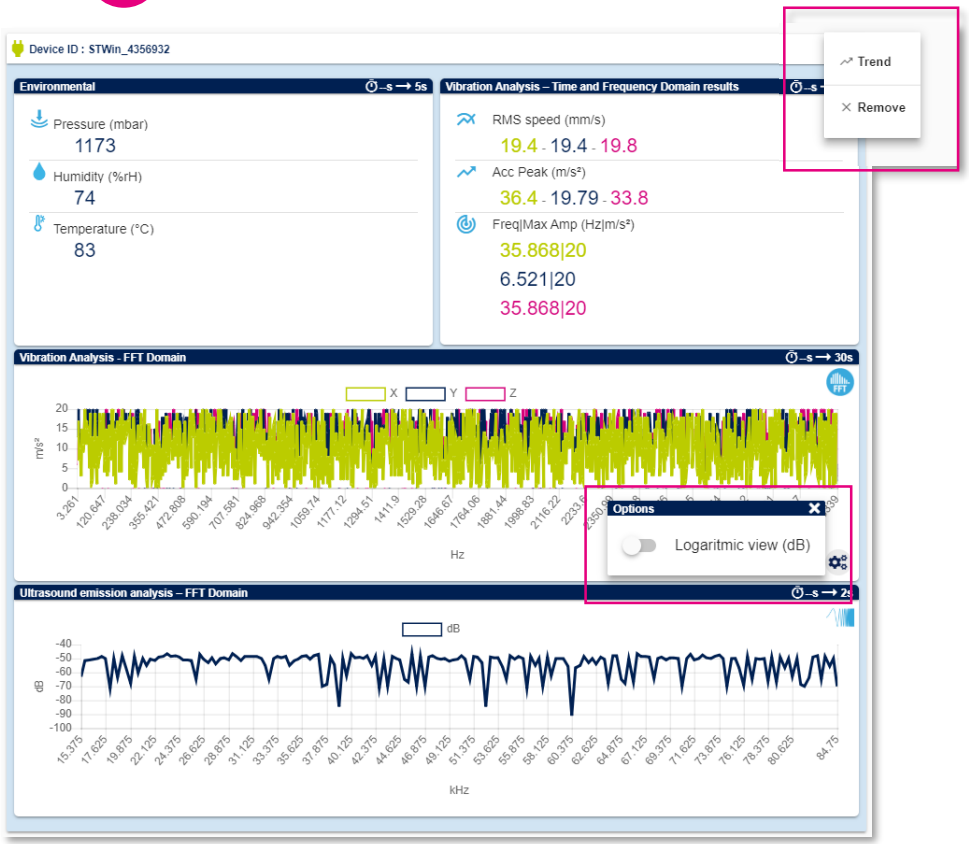
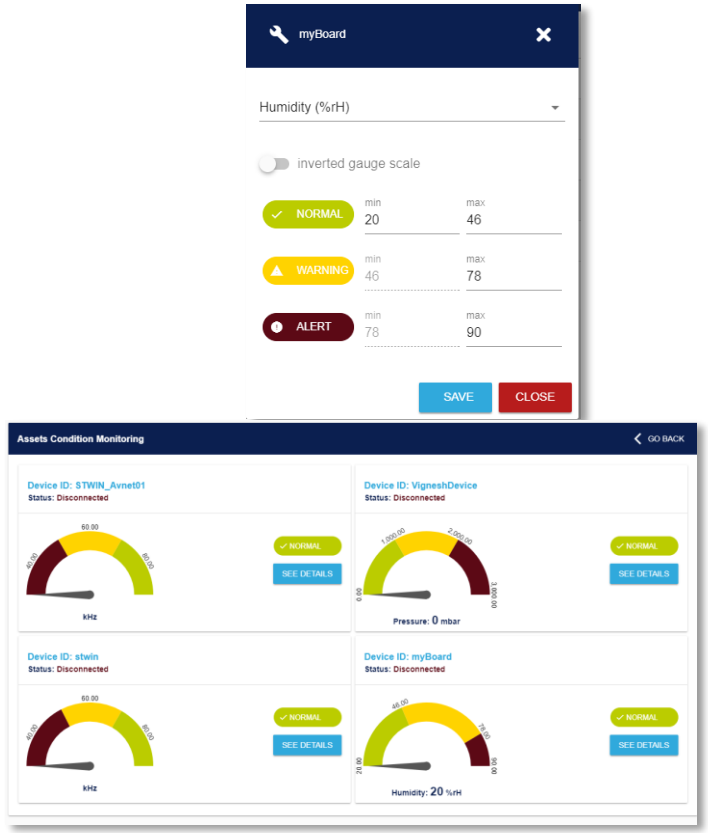
Start the application
Predictive Maintenance Cloud Application (5/5)

1 Add to the dashboard



2 Experiment thresholds

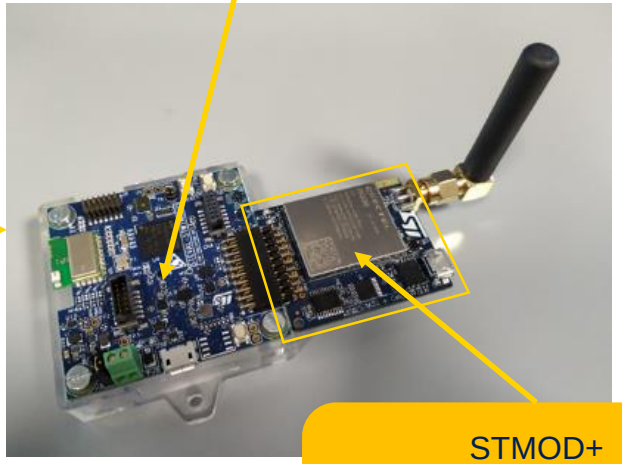


Vibration, Ultrasound and Environmental Monitoring
Quick Start with STMOD+ cellular add-on of P-L496G-CELL02

In this scenario vibration, audio spectrum and environmental parameters such as temperature, humidity and pressure are monitored by using an STEVAL-STWINKT1B as smart sensor node connected by using a STMOD+ cellular add-on board based on Quectel BG96 modem, LTE Cat M1 / NB-IoT / 2G fallback, coming from P-L496G-CELL02 or STEVAL-STMODLTE

1. Get STEVAL-STWINKT1B and STMOD+ cellular add-on board based on Quectel BG96 modem
2. Setup STEVAL-STWINKT1B and add-on board
3. Download the STSW-STWINCELL and download it into STEVAL-STWINKT1B's MCU
4. Register your node at DSH-PREDMNT
5. Set up your network configuration
6. Run the application
7. Monitor the data on DSH-PREDMNT

STEVAL-STWINKT1



STSW-STWINCELL

STMOD+
cellular add-on board
e.g. Quectel BG96 modem
(LTE Cat M1/NB/2G fallback)

NB-IoT

LTE-M

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Vibration, Ultrasound and Environmental Monitoring
Get the Hardware, Download the Software

Buy the Hardware

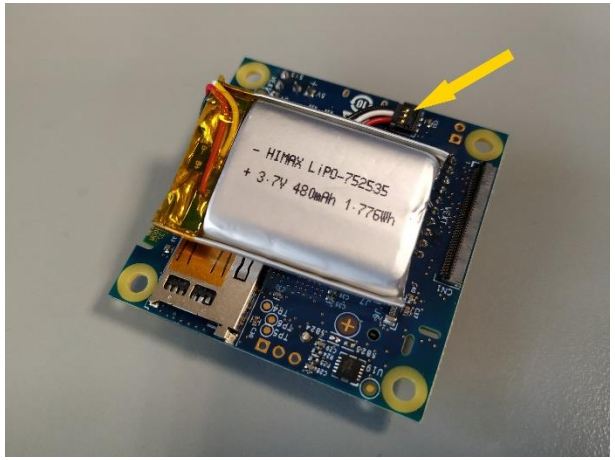
Component	Order code	Description
SensorTile Wireless Industrial Node (STWIN)	STEVAL-STWINKT1B	Predictive maintenance kit with sensors
Expansion board	STMOD+ cellular add-on board based on Quectel BG96 modem coming from P-L496G-CELL02 Or STEVAL-STMODLTE	Adds LTE Cat M1, NB-IoT with 2G fallback connectivity to the STWIN

Get the Software

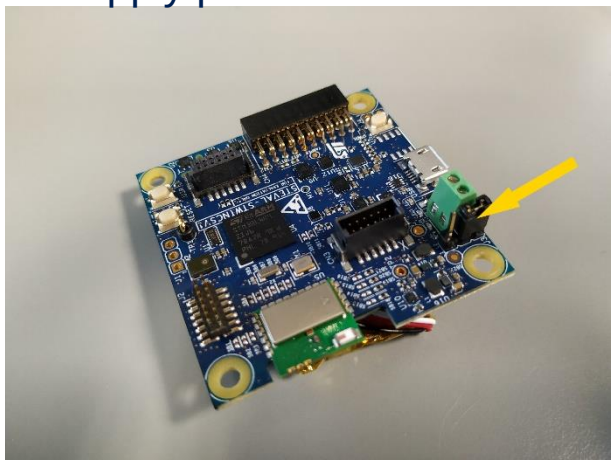
SW Layer Mission	Software Code	Online Distribution
Collect, Preprocess and communicate to the Cloud	STSW-STWINCELL	Binary and source code available for STM32
Visualize data	DSH-PREDMNT	Web based application

Setup STEVAL-STWINKT1 and P-L496G-CELL2 (or STEVAL-STMODLTE)

1. Connect the battery.

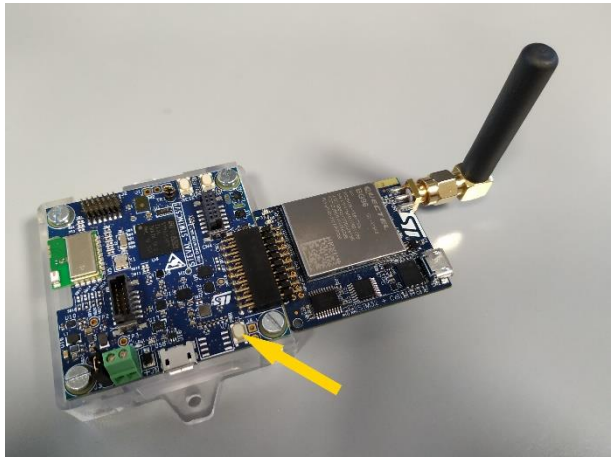


2. Route the right voltage to the power supply pin of the STMOD+ connector.

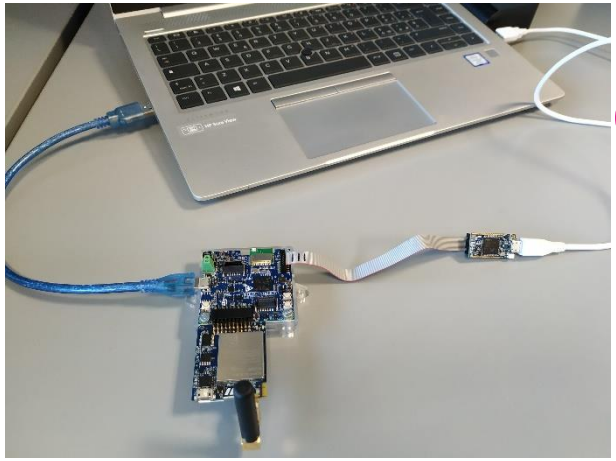


3. Insert the SIM card into the related socket of the STMOD+ cellular add-on board.

4. Assembly the main board with the plastic box and connect the cellular add-on board.



5. Power via USB receptacle and connect the STEVAL-STWINKT1B to a PC via the STLINK-V3MINI



6. Download STSW-STWINCELL binary file into STEVAL-STWINKT1B's MCU

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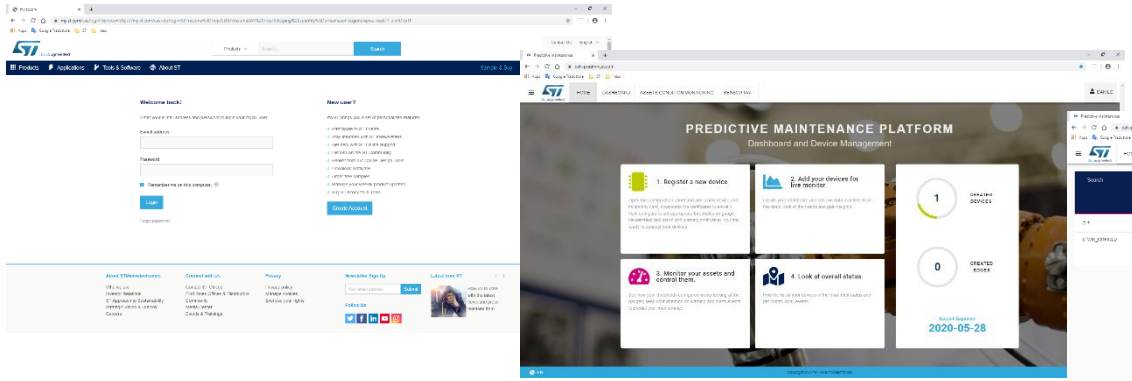
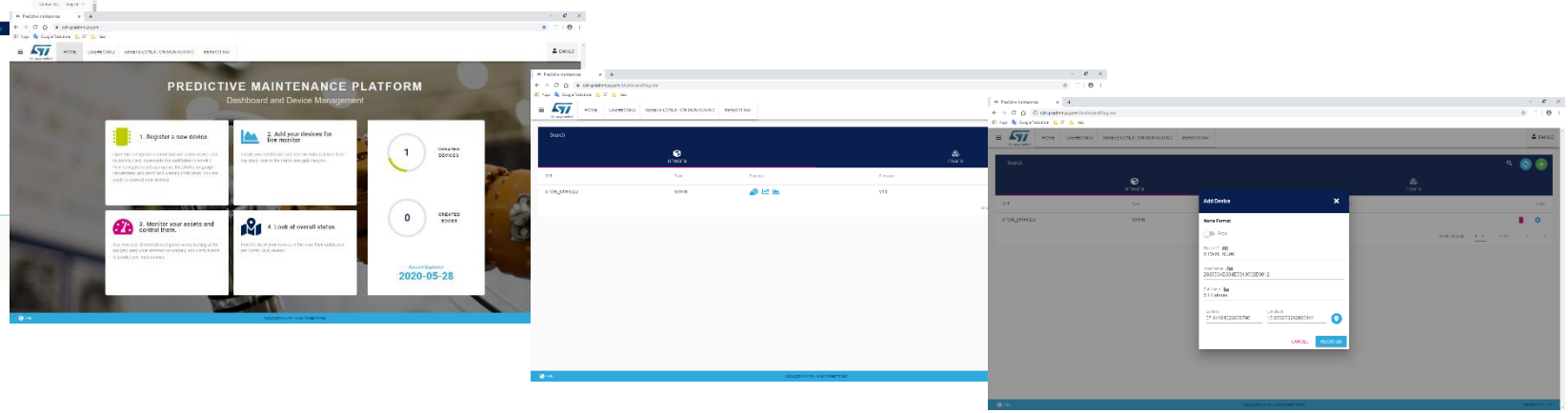
Log in to the dashboard and register the device

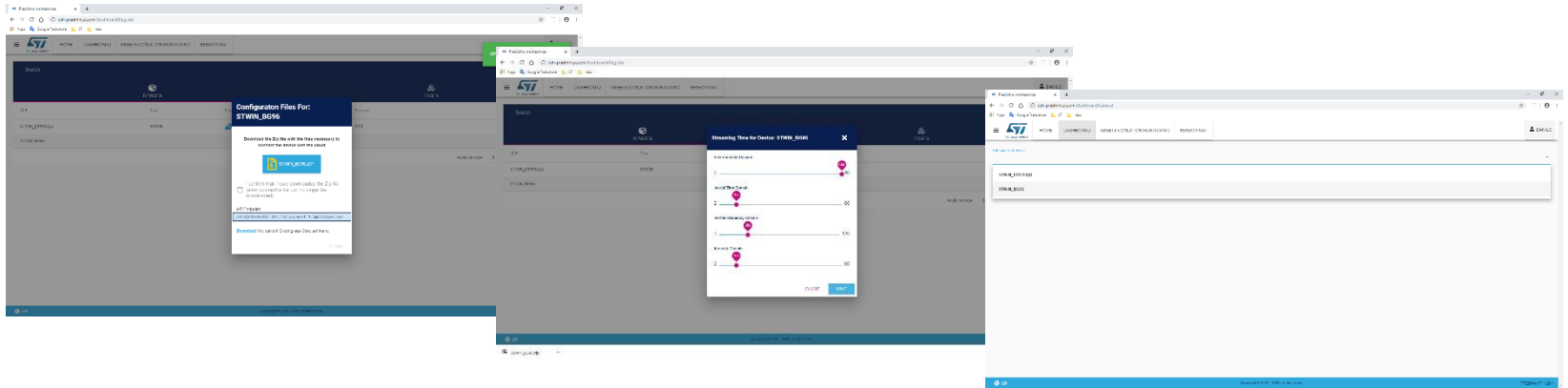
1 Sign Up or Sign In (myST credentials)



2 Add new device and download the zip file containing the certificates



3 Open the device's dashboard



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Run STSW-STWINCELL

Start a terminal emulator software and set the parameters as follow:

- Terminal
  - [New line]
    - [Receive]: AUTO
    - [Transmit]: LF
    - [Local Echo] selected

- Serial
  - [Port]: *as the port assigned to ST-LINK debugger by OS*
  - [Baud rate]: 115200
  - [Data]: 8 bit
  - [Parity]: none
  - [Stop]: 1 bit
  - [Flow control]: none
  - [Transmit delay]: 10 ms each

After pressing the reset button on the STEVAL-STWINKT1 …
… the console will show it

```
************************************************************
***   STWIN - SensorTile Wireless Industrial Node
***      STM32L4R9Z MCU
***   Predictive Maintenance AWS Cloud Demonstration
***   Dashboard URL is https://dsh-predmnt.st.com
***   STSW-STWINCELL V1.0.0 - 13-February-2020
***   CMSIS Core(M) V5.1
***   HAL V1.10.0 RC0
***   Compiled Feb 13 2020 18:39:08 (IAR)
************************************************************

*** Board personalization ***

    A cellular expansion board, MB1329B, provided with the BG96 module
    have to be plugged into the STMOD+ connector.

    MCU Unique device ID is 0x2033334B334E5013002B0012

- Network Interface initialized:
Your Cellular parameters need to be entered to proceed.
Select the SIM slot (0 - External, 1 - Internal):
```

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Configure parameters of STSW-STWINCELL

```
- Network Interface initialized:
Your Cellular parameters need to be entered to proceed.
Select the SIM slot (0 - External, 1 - Internal): 0
You have selected the external SIM.

Enter Sim Operator Access Point Code (e.g. EM or ESEYE1 etc): nbiot.tids.tim.it

You have entered <nbiot.tids.tim.it> as the Sim Operator Access Point Code.

Enter the username (it can be NULL) (max 16 char):

You have entered <> as the username.

Enter the password (it can be NULL) (max 16 char):

You have entered <> as the password.

- Network Interface starting:

*** C2C connection ***


Initializing the cellular module

- Network Interface connecting:
Trying to connect with the external SIM

Waiting for BG96 modem running
Signal not known or not detectable yet (be patient)

.....................................................
Signal Level: -77 dBm

........
C2C module registered

Registration done in 60025 msseconds

Retrieving the cellular operator: "I TIM"

Module initialized successfully: Quectel

ProductID: BG96

FW version: BG96MAR02A09M1G

SIM Id (IccID): 89390100002229786797

- Network Interface started:
   - Device Name : Quectel.
   - Device ID : BG96.
   - Device Version : BG96MAR02A09M1G.
- Network Interface connected:
   - IP address :  10.18.44.41.

Enter server address: (example: xxx.iot.region.amazonaws.com)
```

```
Enter server address: (example: xxx.iot.region.amazonaws.com)
a31pjrd6x4v4ba-ats.iot.eu-west-1.amazonaws.com
read: --->
a31pjrd6x4v4ba-ats.iot.eu-west-1.amazonaws.com
<---

Enter device name: (example: mything1)
STWIN_BG96
read: --->
STWIN_BG96
<---

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-----

.......

Enter your root CA:
```

```
Enter your root CA:
-----BEGIN CERTIFICATE-----
MKKDQTCCAimgAwKBAgKTBmyfz5m/jAo54vB4ikPmljZbyjANBgkphkiG9w0BAQsF
ADA5MQswCQYDVQQGEwVUzEPMA0GA1UEChMGQW1hem9uMRkwFwYDVQQDExBBbWF6
b24gUm9vbCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTM4MDExNzAwMDAwMFowOTEL
MAkGA1UEBhMCVVMxDzANBgNVBAoTBkFtYXpvbjEZMBcGA1UEAxMQQW1hem9uKFWv
b3QgQ0EgMTCCASKwDQYWKoZKhvcNAQEBBQADggEPADCCAQoCggEBALW4gHHKeNXj

      Enter your device certificate:
      -----BEGIN CERTIFICATE-----
      MKKDWjCCAkkgAwKBAgKVAKPWpBtX6wziOY4zOpX19T7aU5owMA0GCSpGSKb3DQEB
      CwUAME0xSzBWBqNVBAsMQkFtYXpvbiBXZWkqU2VybmljZXMqTz1BbWF6b24uY29t
      KEluYy4qTD1TZWF0bGxlkFNUPVbhc2hpbmb0b24qQz1VUzAeFw0yMDAxMDqxNTU5
      NDZaFw00OTEyMzEyMzU5NTlaMB4xHDAaBgNVBAMME0FXUyBWb1QgQ2VybGlmaWNh
      bGUwggEiMA0GCSpGSKb3DQEBAQUAA4KBDwAwggEKAoKBAQCl1MlNC651mpVE58v0

            Enter your device key:
            -----BEGIN RSA PRIVATE KEY-----
            MKKEowKBAAKCAQEApTNTDQuubZpVROfL9DS+BNQY91P7shGzzzaDicSDaW4pQcBl
            jgz1ALsaGwhBpLW4K0hHfR1DZyWK5pnfAp/lg9F233fUyaS5ZmBL8CMWryLsFNOO
            Cy7X/Og3pup/QGnURxX3Abpvx6TWWF2EjNut6Zt9WWMWYOnTPrzADizfDpuBCVi9
            plbFkp/71ZpK1WFEokfHWgsMvN4uvikp6ZQ+U5tjyZgHEFyb7fkhaNTzBt/SnOFW
            jKOP5h2SvMLtcgzOukK+bOBSstEfb6kvUS9PpkrnpF2bmKPL3xf0234YhsbbMlRA
```

1. Select the SIM slot to be used.
   Enter the APN for the cellular network operator you are going to use and the optional credential as well.
   - Wait for the cellular module initialization and its network registration.
2. Enter the AWS IoT Endpoint: **a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com**
   - Enter the Device's name
3. Enter the certificates for the AWS IoT device (you can find it inside the downloaded zip file):
   - Root certificate authority (CA)
   - Device certificate
   - Device private key

Execute STSW-STWINCELL

1

Since the needed parameters have been successfully entered …

- The on board components are going to be initialized.
- The MQTT connection is going to be established.

```
Setting the RTC from the network time.
Connecting to www.gandi.net at ipaddress: 151.101.193.103
20001410 => X:\STSW-STWINCELL\Middlewares\Third_Party\mbedTLS\library\ssl_tls.c:4643:
x509_verify_cert() returned -9984 (-0x2700)


Signal Level: -71 dBm

Configuring the RTC from Date: Tue, 18 Feb 2020 08:46:46 GMT

Initializing the Environmental Sensors ...
- Humidity sensor is ready.
- Pressure sensor is ready.
- Temperature sensor is ready.


Initializing the Inertial Sensor ...
- Accelero sensor is ready.


Initializing the Audio Sensor ...
- Audio sensor is ready.

Shadow Init ...

Shadow Connect ...

MQTT connection in progress:   Attempt 1/3 ...

Signal Level: -77 dBm


Signal Level: -71 dBm


Connected to a31pjrd6x4v4ba-ats.iot.eu-west-1.amazonaws.com:8883
```

2

The cloud shadow will be updated with the features to be monitored.

The streaming time already set on dashboard will be passed to the application running into the STM32.

```
Update Shadow: {"state":{"reported":{"Device_Type":"STWIN","Features":["Environmental",
"Inertial_TDM", "Inertial_FDM",
"Acoustic"],"Firmware":"V1.0","Env_Time":50,"Ine_Time_TDM":50,"Ine_Time_FDM":50,"Aco_Time":50}},
"clientToken":"STWIN_BG96-0"}

Delta - EnvStreamingTime changed to 60

Delta - IneTdmStreamingTime changed to 10

Delta - IneFdmStreamingTime changed to 30

Delta - AcoStreamingTime changed to 10

Update Accepted!

Update Shadow: {"state":{"reported":{"Device_Type":"STWIN","Features":["Environmental",
"Inertial_TDM", "Inertial_FDM",
"Acoustic"],"Firmware":"V1.0","Env_Time":60,"Ine_Time_TDM":10,"Ine_Time_FDM":30,"Aco_Time":10}},
"clientToken":"STWIN_BG96-5"}

Update Accepted!
```

3

According the streaming time the STEVAL-STWINKT1 will publish via the STMOD+ cellular add-on board the data for each feature.

```
Published to topic pm/STWIN_BG96/sense/environmental:
{"Humidity": 34.37, "Pressure": 1028.54, "Temperature": 30.28}

Published to topic pm/STWIN_BG96/sense/acoustic:
{"Aco_FFT":[-72.86,-72.4,-74.61,-75.94,-73.730000000000009,-72.53,-73.92,-76.33,-79.17,-78.39,-
76.7,-77.540000000000009,-81.15,-83.790000000000009,-83.069999999999991,-81.340000000000009,-
80.680000000000009,-81.61,-83.659999999999991,-84.65,-82.519999999999991,-79.94,-80.86,-84.02,-
86.13,-84.57,-82.090000000000009,-81.87,-83.81,-85.91,-85.98,-83.569999999999991,-
83.180000000000009,-84.05,-86.38,-87.84,-85.6,-84.04,-83.94,-86.05,-88.58,-86.1,-84.4,-84.39,-
86.07,-88.99,-88.49,-87.03,-86.13,-86.75,-90.33,-91.59,-88.65,-86.77,-87.42,-89.51,-91.94,-89.95,-

Published to topic pm/STWIN_BG96/sense/inertial_tdm:
{"RMS_Speed": [0.42,0.41,0.11], "Peak_Acceleration": [2.57,3.30,8.12]}

Published to topic pm/STWIN_BG96/sense/inertial_fdm:
{"Ine_FFT":
[[0.00,0.00,0.00,0.00],[25.96,0.00,0.00,0.01],[51.91,0.01,0.00,0.01],[77.87,0.01,0.00,0.01],[103.83,
0.01,0.01,0.01],[129.79,0.01,0.01,0.01],[155.74,0.01,0.01,0.01],[181.70,0.01,0.01,0.01],[207.66,0.01
,0.01,0.01],[233.61,0.01,0.01,0.01],[259.57,0.01,0.01,0.01],[285.53,0.01,0.01,0.01],[311.48,0.01,0.0
1,0.01],[337.44,0.01,0.01,0.01],[363.40,0.01,0.01,0.01],[389.36,0.01,0.01,0.01],[415.31,0.01,0.01,0.
01],[441.27,0.01,0.01,0.01],[467.23,0.01,0.01,0.01],[493.18,0.01,0.01,0.01],[519.14,0.01,0.01,0.01],
```

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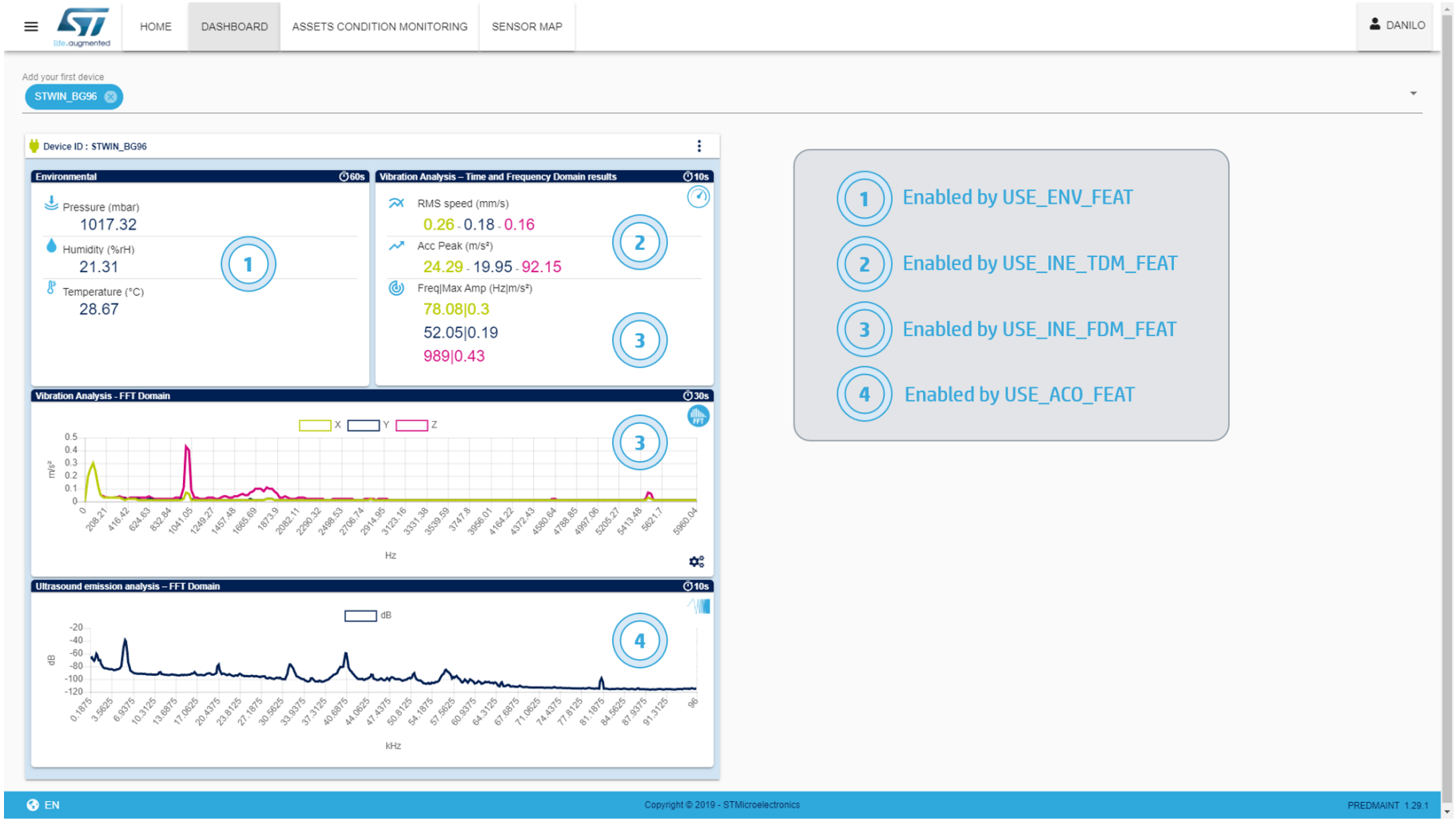
Populated ST Predictive Maintenance Dashboard while running STSW-STWINCELL

The features that will be used can be selected during FW compiling.

The user can choose from one up to all four features acting on the values of the following key words inside the file ‘aws_iot_config.h’:

- USE_ENV_FEAT
- USE_INE_TDM_FEAT
- USE_INE_FDM_FEAT
- USE_ACO_FEAT



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Anomaly detection
STWIN and FP-AI-PREDMNT2

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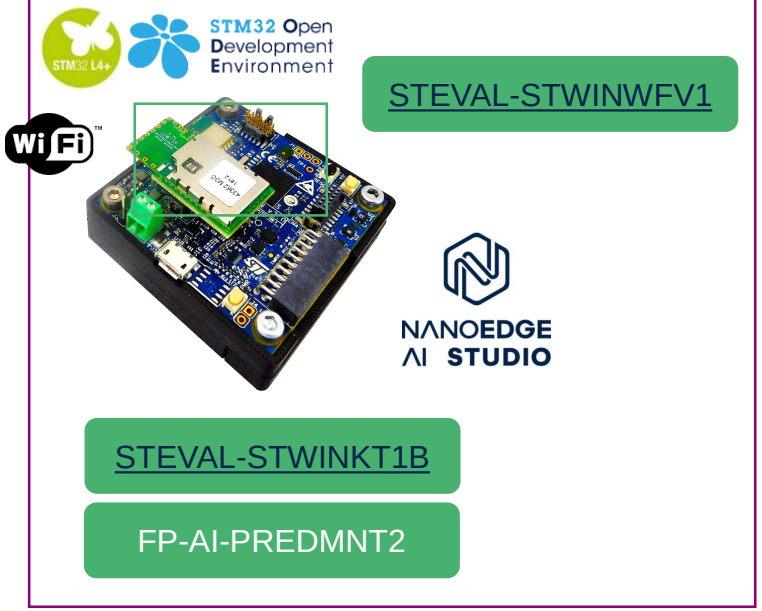
Anomaly Detection with NanoEdge AI Studio
how to start

- ST Evaluation Tools and SW Packages on your hand, you can combine both approach as you may need
- Google Chrome, view directly in your browser the data coming thanks to DSH-PREDMNT application

Quick start

End to end architecture based on Wireless Smart Sensor Nodes (WIFI – LPWAN) – FP-AI-PREDMNT2



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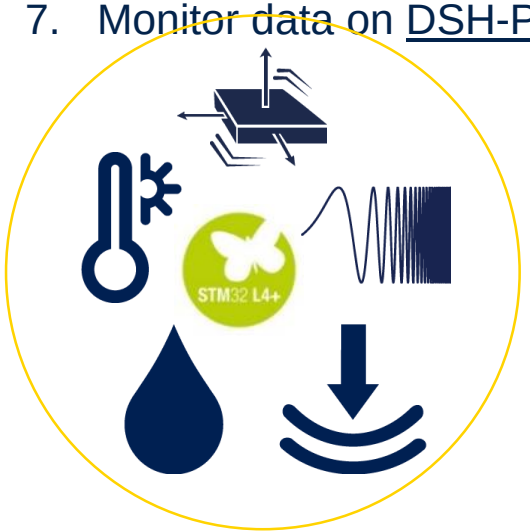
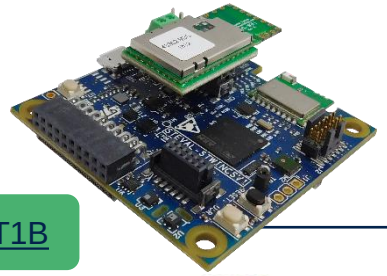
Anomaly Detection with NanoEdge AI Studio
Quick Start with WIFI expansion STEVAL-STWINWF1

In this scenario a motor is monitored by using an STEVAL-STWINKT1B as smart sensor node connected by using the WIFI expansion module (STEVAL-STWINWFV1) and the smart sensor node is provisioned.

1. Get STEVAL-STWINKT1B and STEVAL-STWINFV1
2. Generate NanoEdge AI Studio library
3. Download the FP-AI-PREDMNT2 and Flash it
4. Register your node at DSH-PREDMNT
5. Configure Wifi and DSH-PREDMNT credentials through BLE Sensor App
6. Run the application
7. Monitor data on DSH-PREDMNT

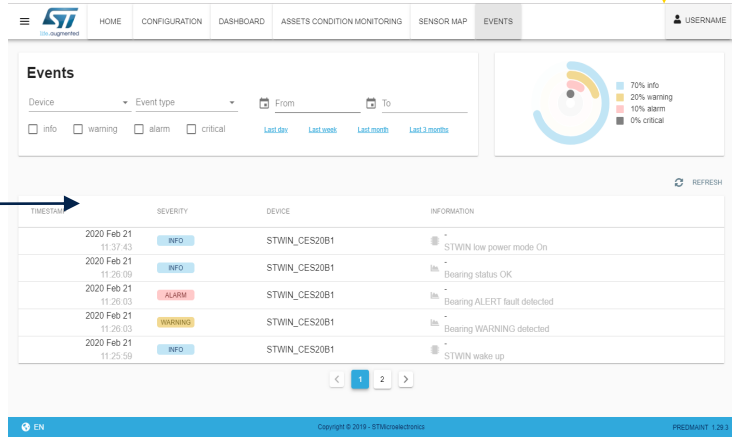


STEVAL-STWINWFV1



STEVAL-STWINKT1B

NANOEDGE AI STUDIO



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Setup a NanoEdge™ AI library into FP-AI-PREDMNT2

Generating contextual data using FP-SNS-DATALOG1

Build library using NanoEdge™ AI Studio

Embed and use into FP-AI-PREDMNT2

Capture data	Label data	Build NanoEdge Lib	Embed NanoEdge Lib	Process new data
Accelerometer	Normal Anomaly	Modeling Results	NanoEdge integration NanoEdge implementation	Real-time learning
1	2	3	4	5

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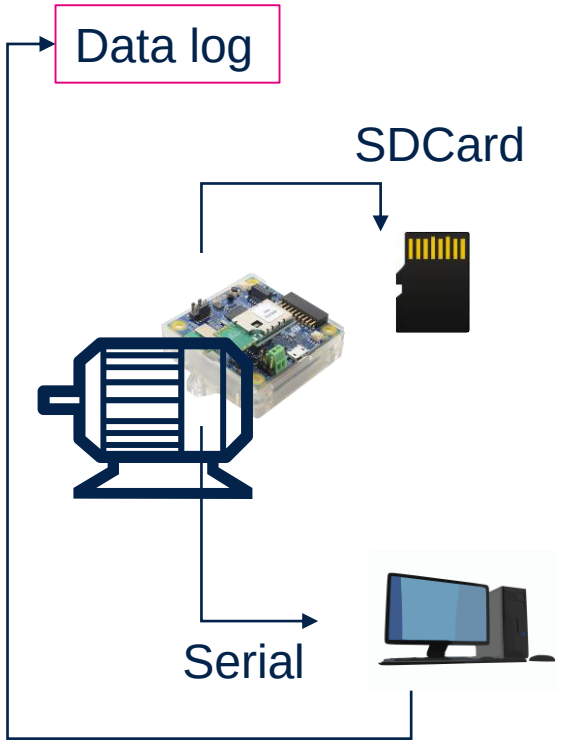
Capture data and create a labelled dataset

Generating contextual data using FP-SNS-DATALOG1

1 Generate data set



2 Label Data

Regular signals file.csv

Abnormal signals file.csv

normalDataFull.csv

abnormalDataFull.csv

Use NanoEdge AI Studio tool

Build library using NanoEdge™ AI Studio

3 Building and Export Library file

1. `Libneai.a`
2. `NanoEdgeAI.h`

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Setup & Demo Examples

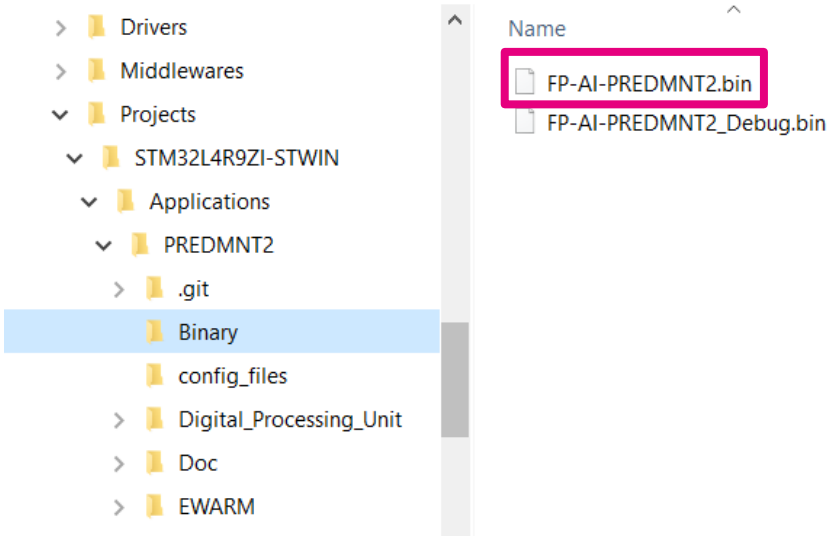
Firmware update

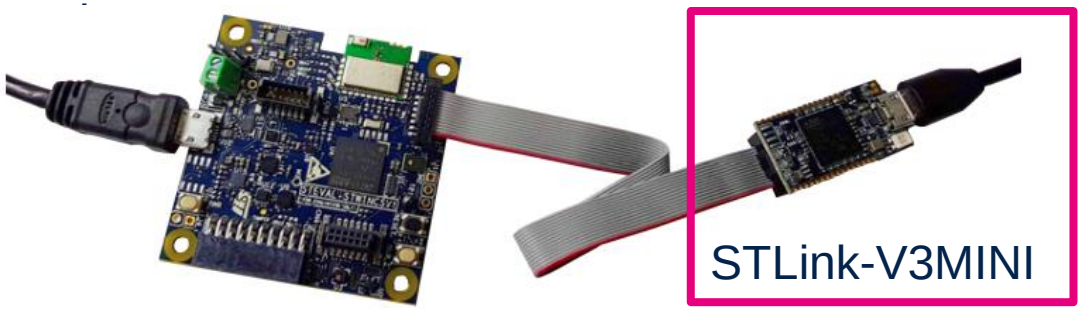
FP-AI-PREDMNT2 **is not** the default firmware on the STEVAL-STWINKT1B, so it needs to be downloaded on the board by the user.

The easiest way is to use the **pre-compiled binary** provided in the package in the folder Projects\STM32L4R9ZI-STWIN\Applications\PREDMNT2\Binary.

To update the firmware:

- Connect the STWIN core system board to the STLINK-V3MINI programmer.
- Connect both the boards to a PC using micro USB cables.
- Open STM32CubeProgrammer, select the proper binary file download the firmware.





For further details, see **UM2937**

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FP-AI-PREDMNT2

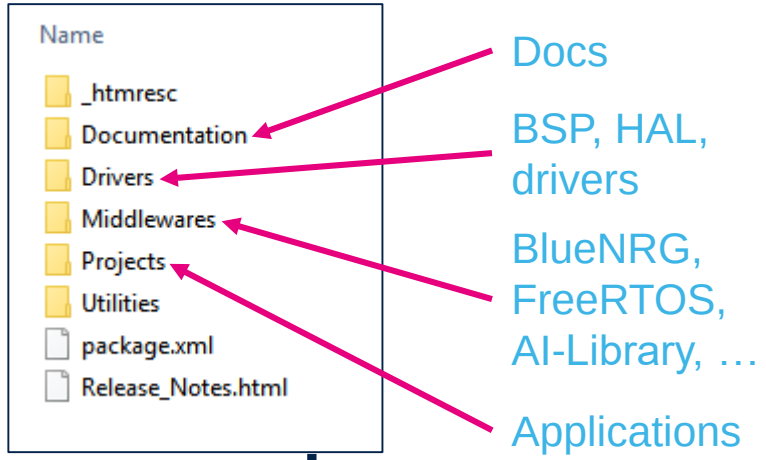
Setup Overview

1. www.st.com/stm32ode-fp

2. Select Function Pack: FP-AI-PREDMNT2

3. Download & unpack

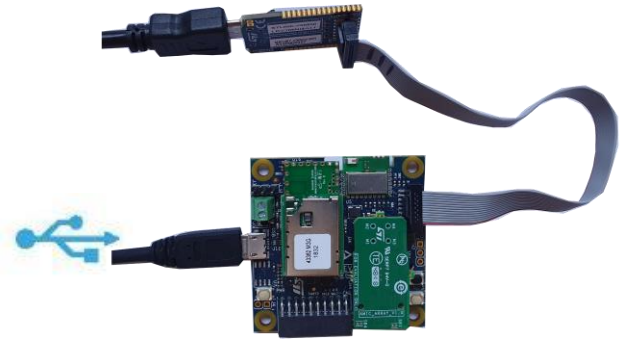
FP-AI-PREDMNT2 package structure



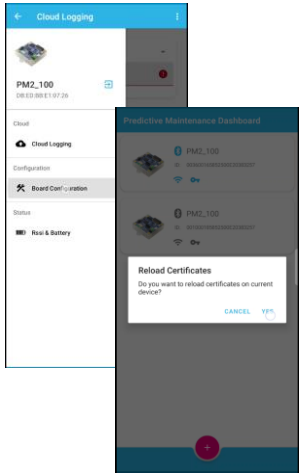
4. Projects\STM32L4R9ZI-STWIN\Applications\PREDMNT2\

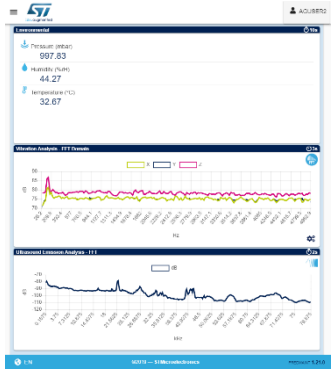
KEIL Tools by ARM | IAR SYSTEMS | STM32 CubeIDE

5.



6. Configure the board through ST BLESensor app and monitor the application through the ST DSH-PREDMNT dashboard





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Integration in the FP and Running

Embed and use into FP-AI-PREDMNT2

4 Integrate Lib files into the project

STM32_PREDMNT1_TMP.git/FP_AI_NANOEDG1/Middlewares/Third_Party/Cartesiam_NanoEdge_AI_Library/

Name

Inc

lib → `NanoEdgeAI.h`

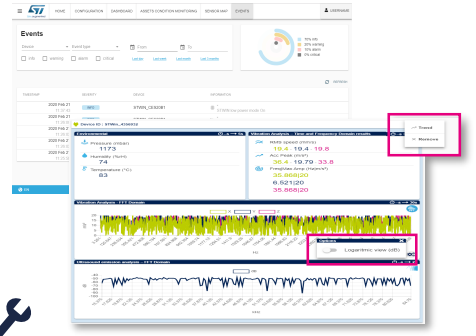
→ `Libneai.a`

5 Re-compile the FP

6 NanoEdge Learn

NanoEdgeAI_learn()

7 Run the demo: NanoEdgeAI execute



NanoEdgeAI_execute()

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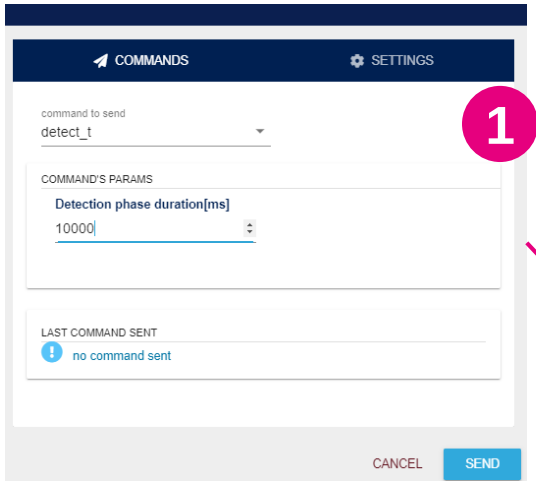
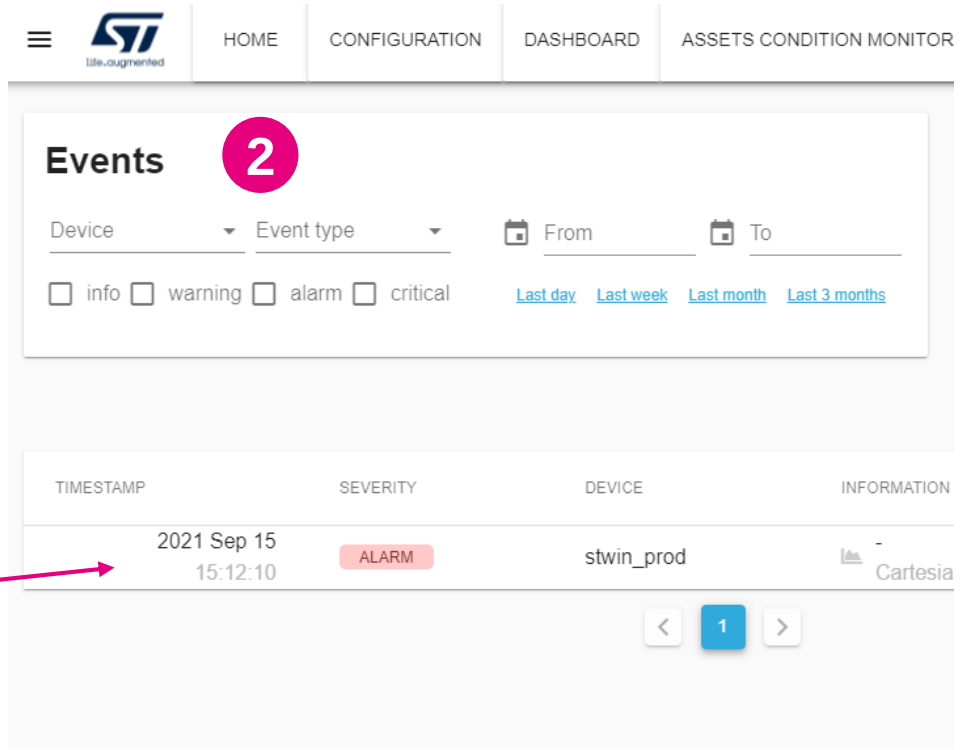
Detection phase of NanoEdge™ AI library



Start detection

Orange led is blinking

Alarm sent



- If the detect command is set, in according with the custom NanoEdge™ AI library, an anomaly event is sent to the dashboard and an event will be shown in the EVENTS panel of the dashboard.
- For further details on how NanoEdge™ AI libraries work, read the detailed documentation of NanoEdge™ AI Studio.

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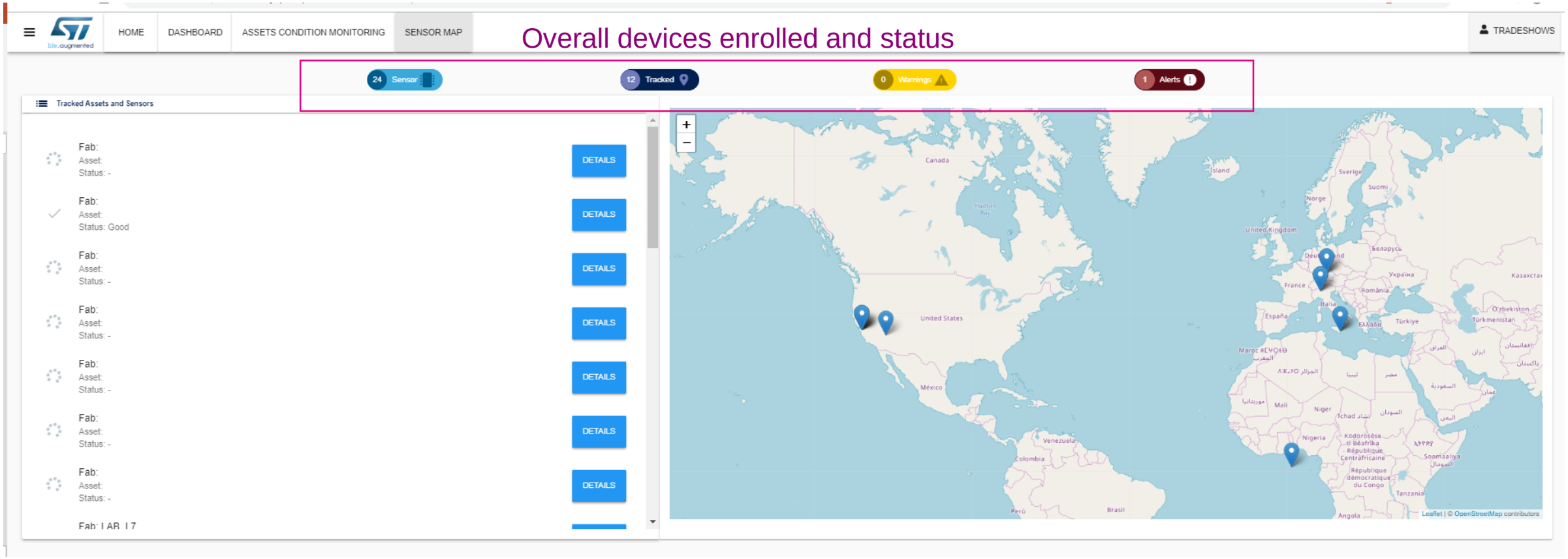
Predictive Maintenance Dashboard
Register other devices and get the Full Picture



Assets and Status

Geo localization

Thank you

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