

PREDICTIVE MAINTENANCE PLATFORM

Dashboard and Device Management

re a device

and add a new device and
e certificates to enroll it. Set
ng notifications.



2. Add your devices for live monitor

Create your dashboard and see live data real-time from the cloud, look at the trends and gain insights.



your assets and
m

gured works looking at the
n warning and alerts events



4. Look at overall status

Find the list of your devices in the map, their status and get control of all events.



Account Expiration
2020-04-



life.augmented

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

Predictive Maintenance Dashboard

Why, how, what?

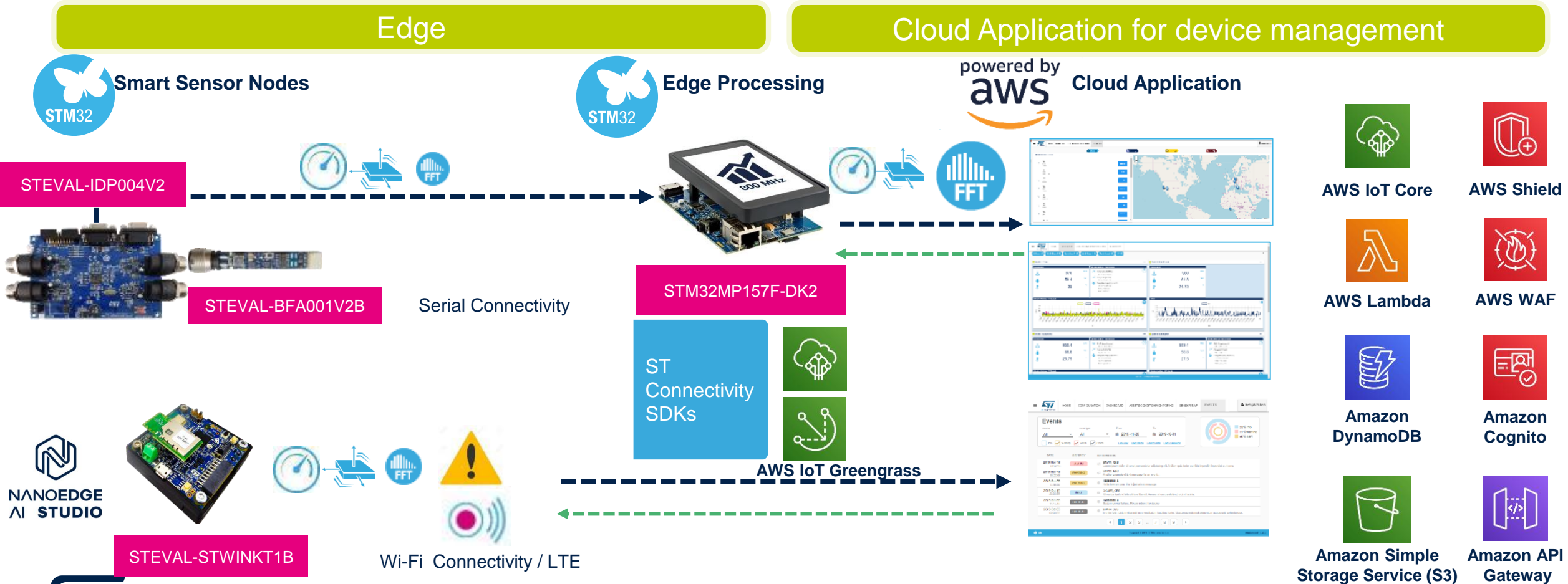
STMicroelectronics wants to enable customers to fast implement Proof Of Concept on condition monitoring and predictive maintenance from an end to end perspective.

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

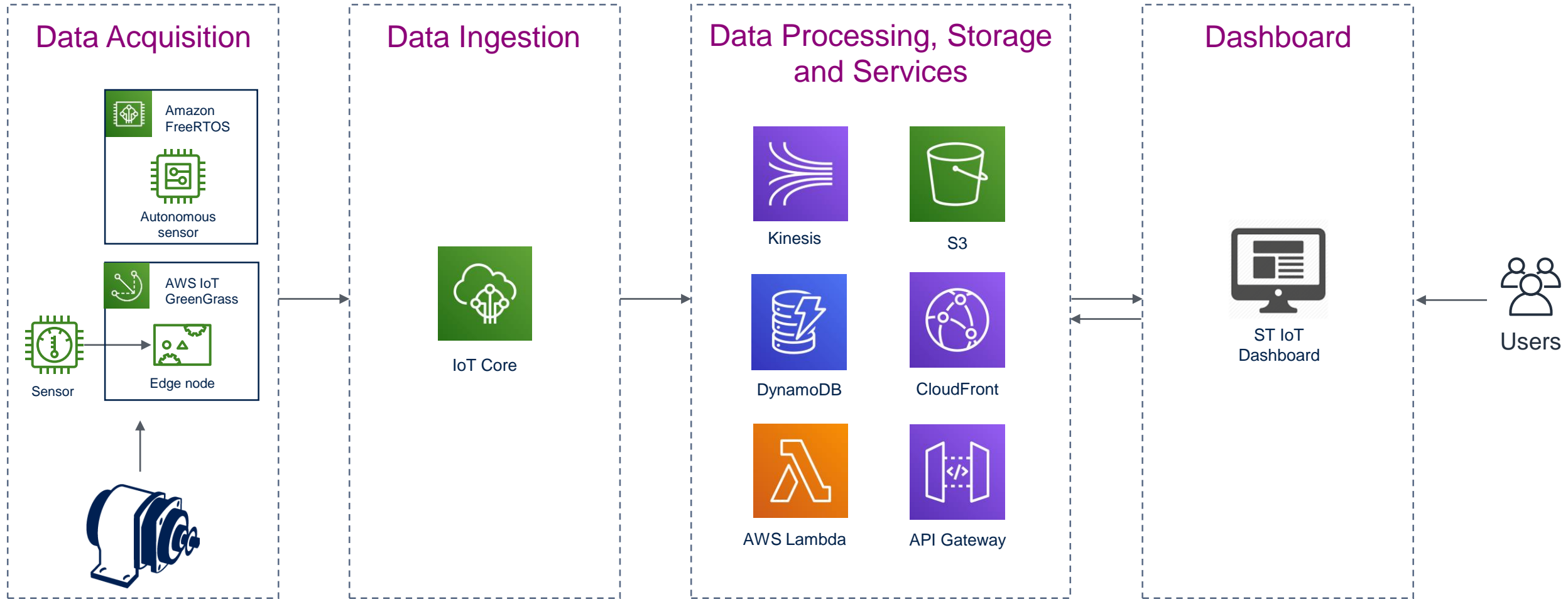


NANOEDGE
AI STUDIO



STEVAl-STWINKT1B

Simplified Architecture



Predictive Maintenance Dashboard

AWS services by class

Management and Governance



Amazon CloudWatch

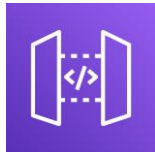


AWS CloudFormation

Networking and Content Delivery



Amazon CloudFront



Amazon API Gateway

Application core modules: IoT, Compute, Database and Storage



AWS IoT Core



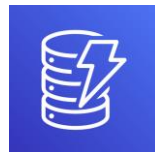
AWS IoT Greengrass



Kinesis



AWS Lambda



Amazon DynamoDB



Amazon Simple Storage
Service (S3)

User identify and security



Amazon Cognito



AWS Shield



AWS Identity and Access
Management (IAM)

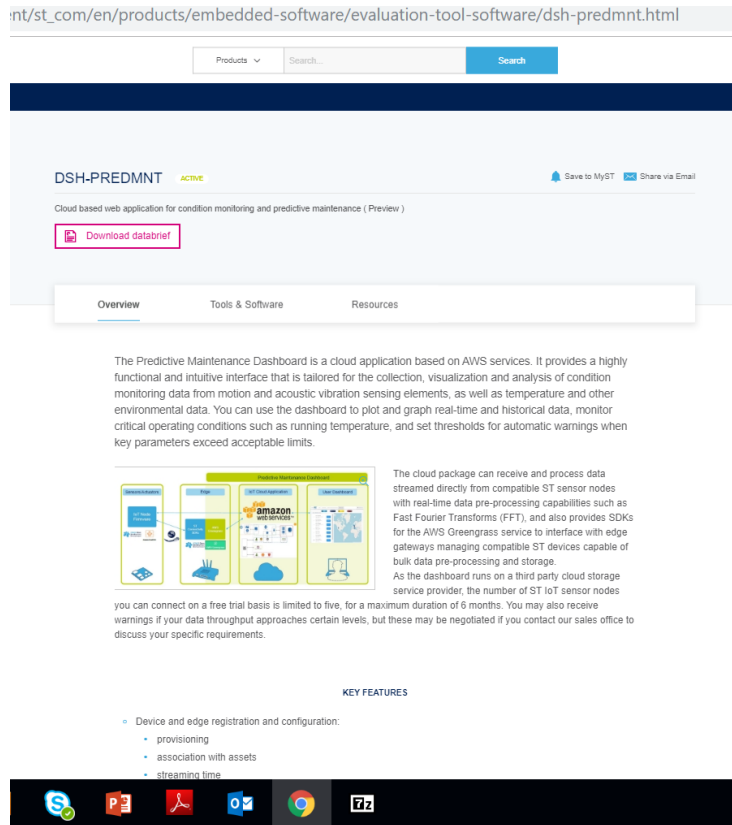


AWS WAF

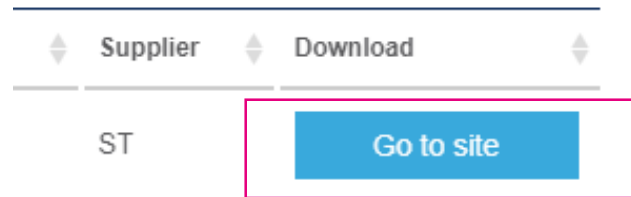
Predictive Maintenance Dashboard

How can I access?

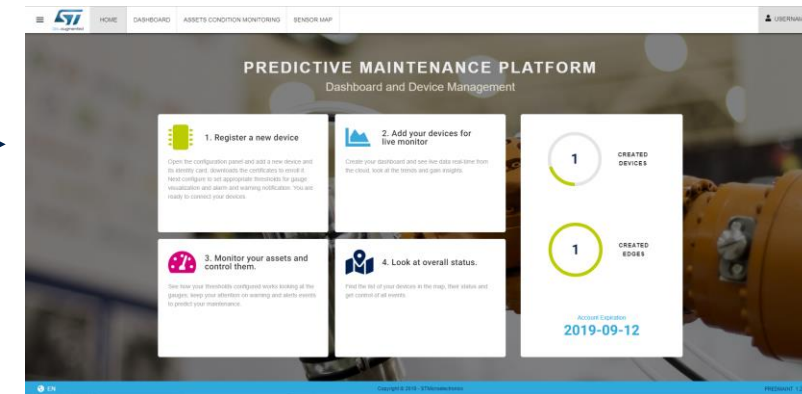
https://www.st.com/content/st_com/en/products/embedded-software/evaluation-tool-software/dsh-predmnt.html



ST.com/DSH-Predmnt



• dsh-predmnt.st.com





life.augmented

Run the application

Predictive Maintenance Dashboard

Run the Application in limited free usage

ST.com/DSH-Predmnt

Supplier Download

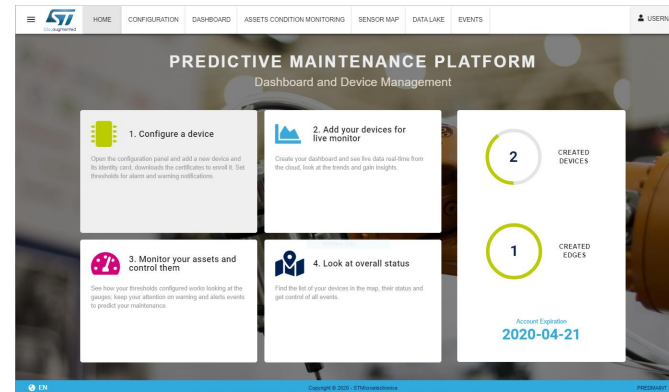
ST

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

Sign the Terms of Usage and go

1



Products Search Contact Us English

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Welcome back!

Enter your e-mail address and password to login your myST user.

E-mail address

Password

☐ Remember me on this computer.

Login

Forgot password?

New user?

myST brings you a set of personalized features:

- Participate to ST Events
- Stay informed with ST eNewsletters
- Get help with ST Online Support
- Discuss on the ST Community
- Benefit from our Online Design Tools
- Download Software
- Order free samples
- Manage your weekly product updates
- Buy ST Products & Tools

Support

Create Account

2

Terms of Usage

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login and accept
Terms of Usage

3



HOME CONFIGURATION DASHBOARD ASSETS CONDITION MONITORING SENSOR MAP DATA LAKE EVENTS USERNAME

PREDICTIVE MAINTENANCE PLATFORM
Dashboard and Device Management

1. Configure a device
Open the configuration panel and add a new device and its identity card, downloads the certificates to enroll it. Set thresholds for alarm and warning notifications.

2. Add your devices for live monitor
Create your dashboard and see live data real-time from the cloud, look at the trends and gain insights.

3. Monitor your assets and control them
See how your thresholds configured works looking at the gauges, keep your attention on warning and alerts events to predict your maintenance.

4. Look at overall status
Find the list of your devices in the map, their status and get control of all events.

2 CREATED DEVICES

1 CREATED EDGES

Account Expiration
2020-04-21

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Redirect to the
dashboard

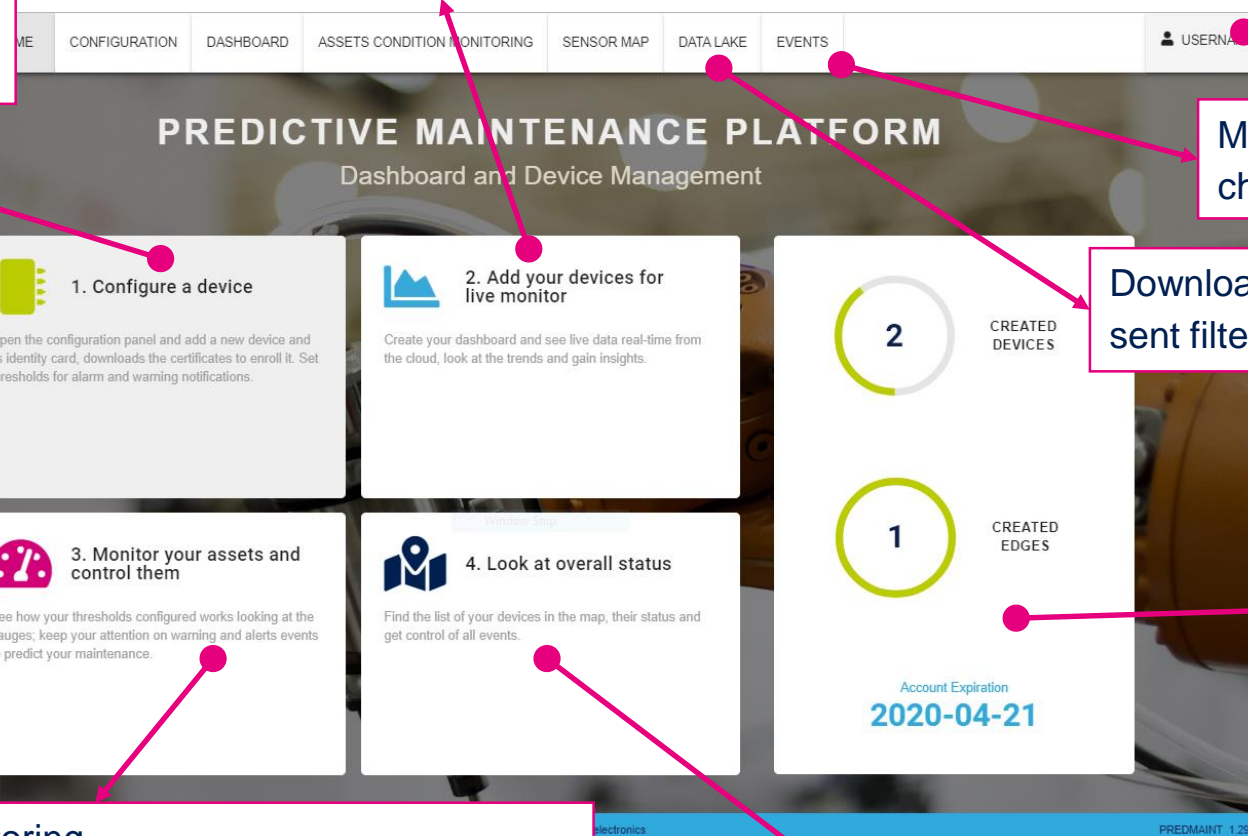
Predictive Maintenance Dashboard

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

Info Panel for the user about its terms

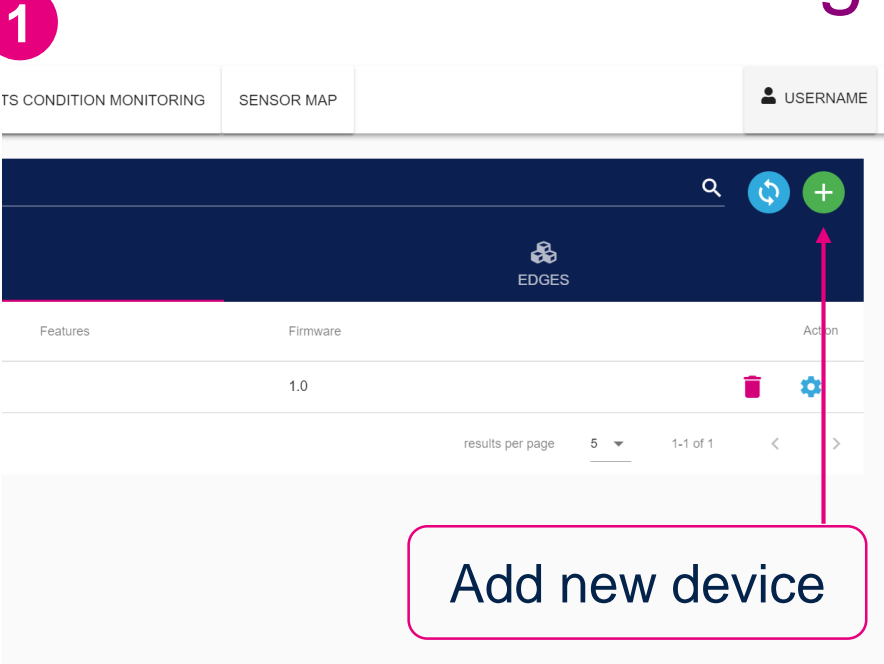
Assets Map

English and Chinese

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

Predictive Maintenance Dashboard

Register, add, remove and manage a device



2

Compile form

Add Device

Name Format

☐ Free

Device ID STWin_4356932

Asset Name Engine_Control_Room

Fab Name Example

12.43651 22.3124

CANCEL REGISTER

3

Configuraton Files For: STWin_4356932

Download the Zip file with the files necessary to connect the device with the cloud

STWIN_4356932.ZIP

☒ I confirm that I have downloaded the Zip file (after closing the file can no longer be downloaded)

IoT Endpoint:
a36fch9jjgxjps-ats.iot.eu-west-1.amazonaws.com

[Download](#) the current Greengrass Core software.

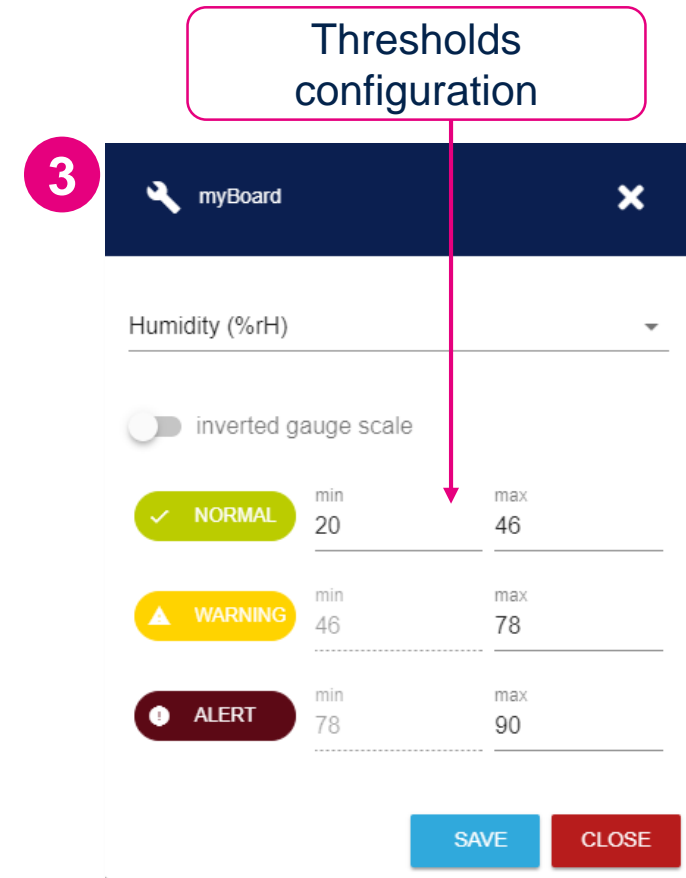
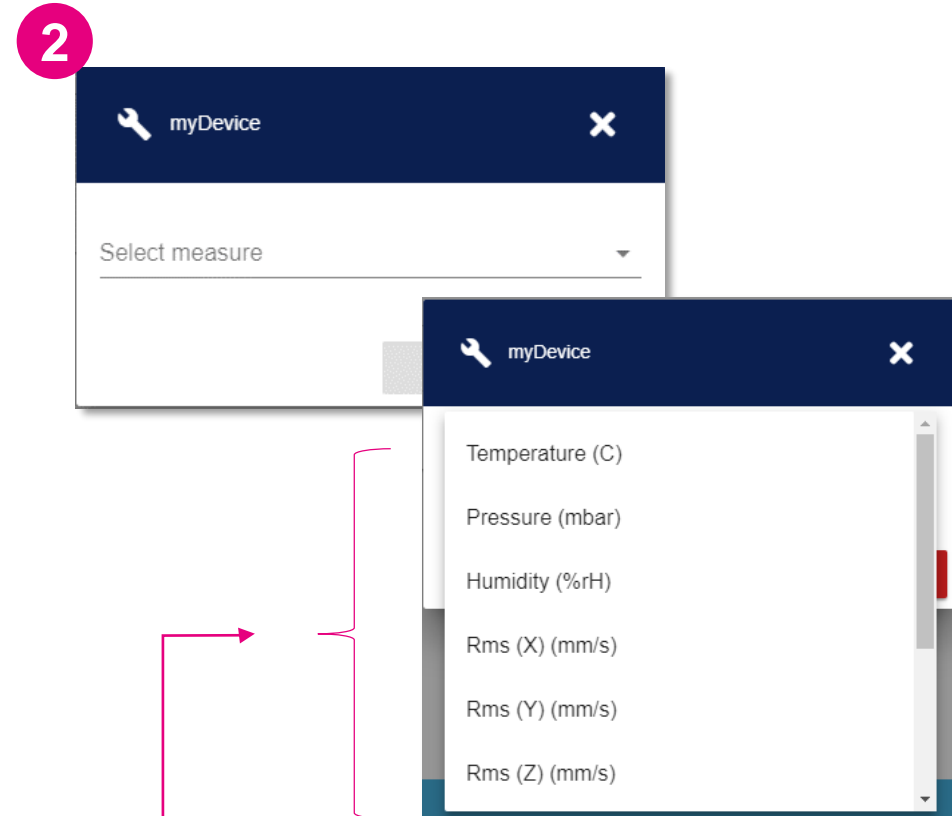
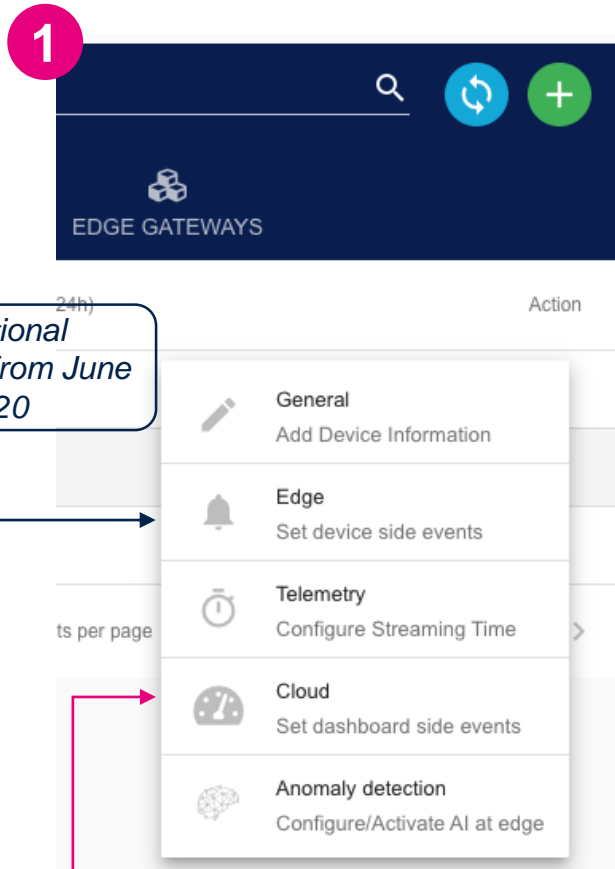
CLOSE

Latitudes and longitudes coordinates

Download device certificate and take note of IoT endpoint

Predictive Maintenance Dashboard

Configure measures and condition monitoring thresholds



Predictive Maintenance Dashboard

Set Ultrasound FFT filter



Predictive Maintenance Dashboard

Register and manage an AWS Greengrass Group

1

Add New Edge


Edge Name:

[CANCEL](#) [ADD GROUP](#)

Create new group...

Registration Files For: ST_Edge_01

Upload the Zip file with the files necessary to connect the device with the cloud

 **ST_EDGE_01.ZIP**

☐ I confirm that I have downloaded the Zip file (after closing the file can no longer be downloaded)

IoT Endpoint:

[Download](#) the current Greengrass Core software.

[CLOSE](#)

2




EDGES

Action

- Devices
- Deploy**
- Reset Deploy

...deploy it

3

Status	Deployment Type	Action
	New Deployment	 

results per page 5 1-1 of 1

Predictive Maintenance Dashboard

Hand Shaking Device - Cloud

CONDITION MONITORING

SENSOR MAP

STWIN_CES01

Type	Features	Firmware
STWIN		V1.1

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

Predictive Maintenance Dashboard Hand Shaking Device – Flexible visualization

Environmental domain

Vibration (FFT) domain

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

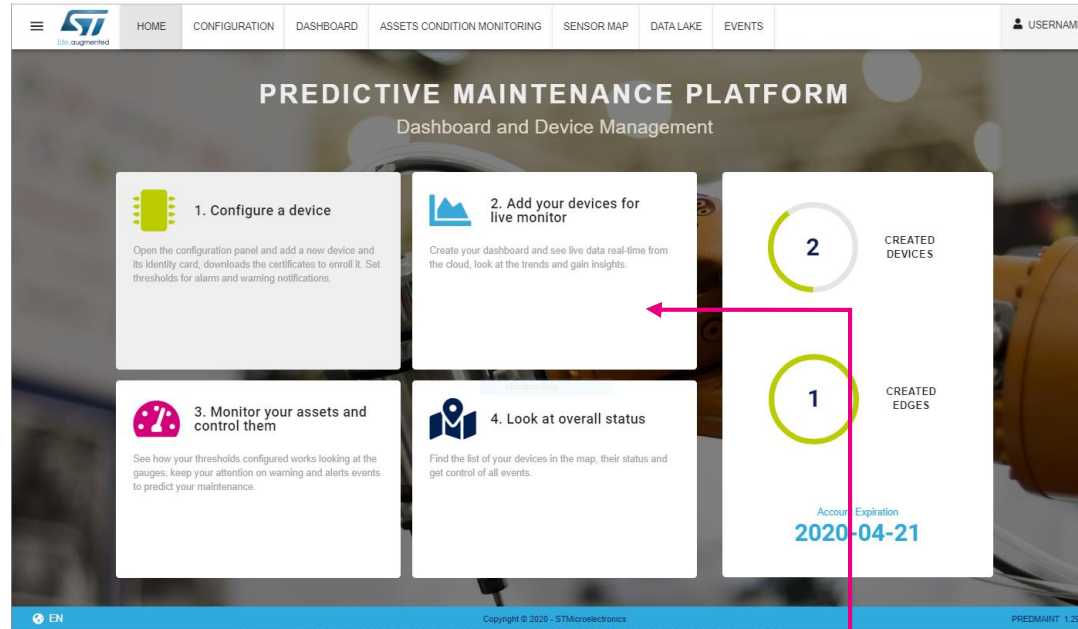


Vibration Analysis: TD & FD results

Acoustic (FFT) domain

Predictive Maintenance Dashboard

Add a device to live monitoring



Select your device
for live monitoring



Predictive Maintenance Dashboard

Assets Monitoring

PREDICTIVE MAINTENANCE PLATFORM
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4. Look at overall status
of your devices in the map, their status and of all events.

CREATED DEVICES: 2
CREATED EDGES: 1

Account Expiration
2020-04-21

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Assets Condition Monitoring [GO BACK](#)

Device ID: STWIN_Avnet01
Status: Disconnected
Gauge: kHz (0.00 to 60.00) **NORMAL** [SEE DETAILS](#)

Device ID: VigneshDevice
Status: Disconnected
Gauge: Pressure: 0 mbar (0.00 to 3.000.00) **NORMAL** [SEE DETAILS](#)

Device ID: stwin
Status: Disconnected
Gauge: kHz (0.00 to 60.00) **NORMAL** [SEE DETAILS](#)

Device ID: myBoard
Status: Disconnected
Gauge: Humidity: 20 %rH (20.00 to 100.00) **NORMAL** [SEE DETAILS](#)

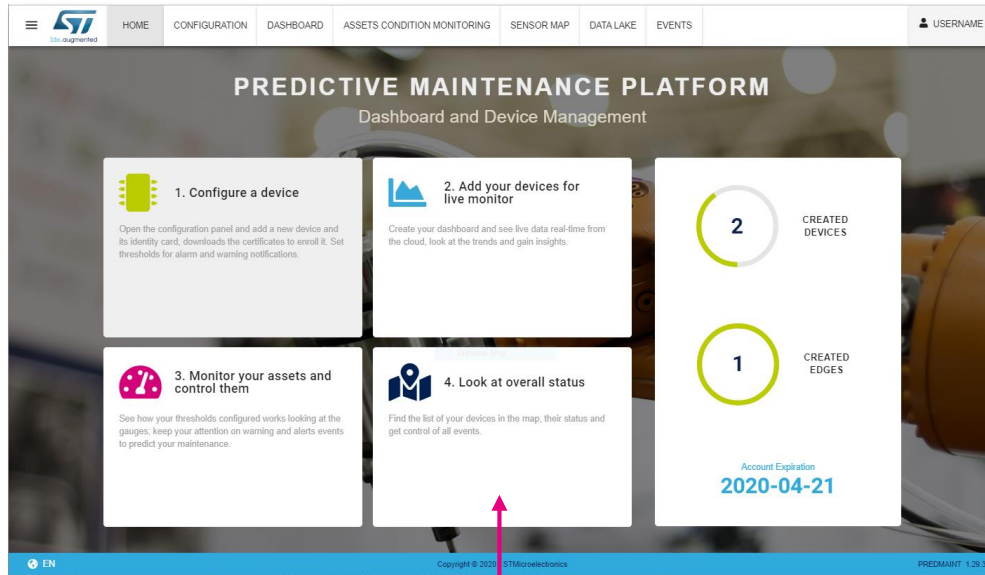
Set Thresholds Modal:
Humidity (%rH)
☐ inverted gauge scale

Level	min	max
NORMAL	20	46
WARNING	46	78
ALERT	78	90

[SAVE](#) [CLOSE](#)

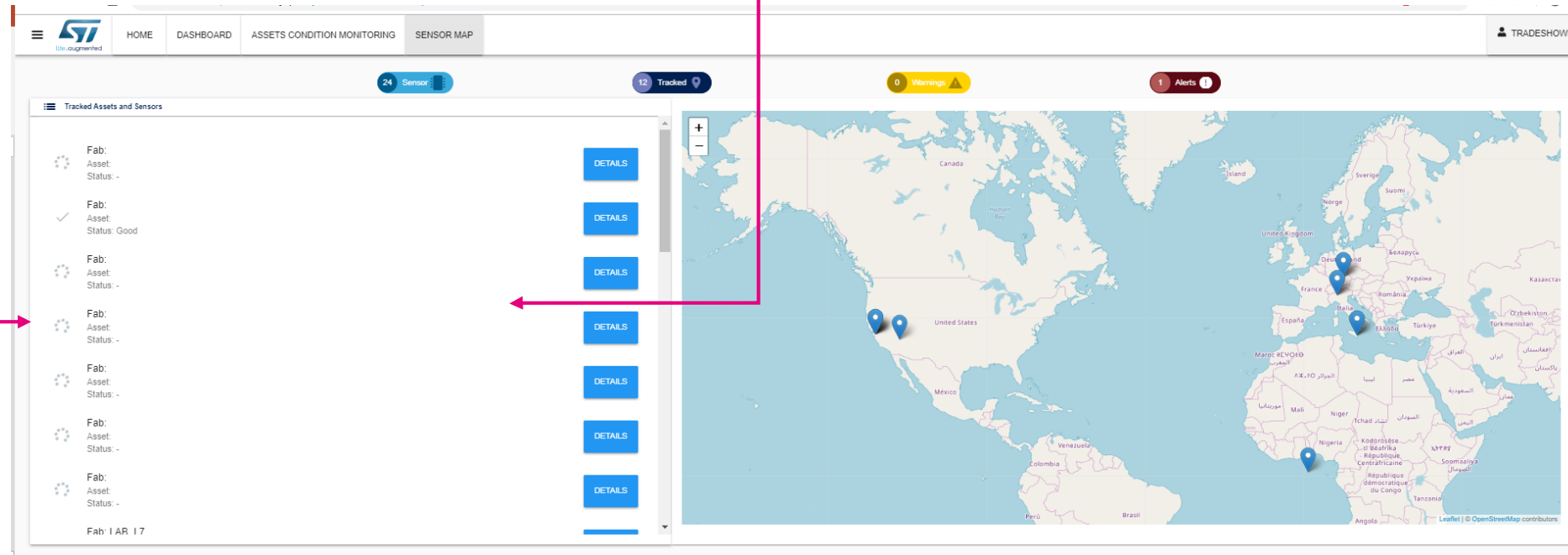
Predictive Maintenance Dashboard

Assets Map



Assets and Status

Geo-localization



Predictive Maintenance Dashboard

Data Download

Devices and Time Periods

Select, from your collection, the devices and the historical time period for the download.

Select devices Select time period

Telemetry Domains

Select, for each device, the domain of measures related to be included into the download.

Start download

Click on the download button to execute the operation.

RESET DOWNLOAD

Entry point

User can download 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.

Predictive Maintenance Dashboard

Data Download

Devices selection

Time period selection

Domains selection for each device

Download button

The screenshot shows the 'Data Download' section of the Predictive Maintenance Dashboard. The interface includes a top navigation bar with the ST logo, 'life.augmented' text, and menu items: HOME, CONFIGURATION, DASHBOARD, DATA LAKE, and EVENTS. A user profile icon labeled 'USERNAME' is on the right. The main content area is titled 'Devices and Time Periods' and contains instructions: 'Select, from your collection, the devices and the historical time period for the download.' Below this, there are two sections: 'Telemetry Domains' and 'Start download'. The 'Telemetry Domains' section has instructions: 'Select, for each device, the domain of measures related to be included into the download.' It features two columns for device selection: 'demo1' and 'demo2'. Each column lists four domains: Environmental, TDM, FDM, and Acoustic, each with a checkbox and an icon. The 'demo1' column has checkboxes for TDM and Acoustic selected. The 'demo2' column has checkboxes for Environmental, TDM, and FDM selected. Below the domain selection, there are 'RESET' and 'DOWNLOAD' buttons. The 'DOWNLOAD' button is highlighted in dark blue. Annotations with pink dashed arrows point to the 'demo1' and 'demo2' device selection areas, the 'Last month' time period selection, the domain selection checkboxes for each device, and the 'DOWNLOAD' button.

Devices and Time Periods

Select, from your collection, the devices and the historical time period for the download.

Select devices: demo1 demo2

Select time period: Last month

Telemetry Domains

Select, for each device, the domain of measures related to be included into the download.

demo1

- ☐ Environmental
- ☒ TDM
- ☐ FDM
- ☒ Acoustic

demo2

- ☒ Environmental
- ☒ TDM
- ☒ FDM
- ☐ Acoustic

Start download

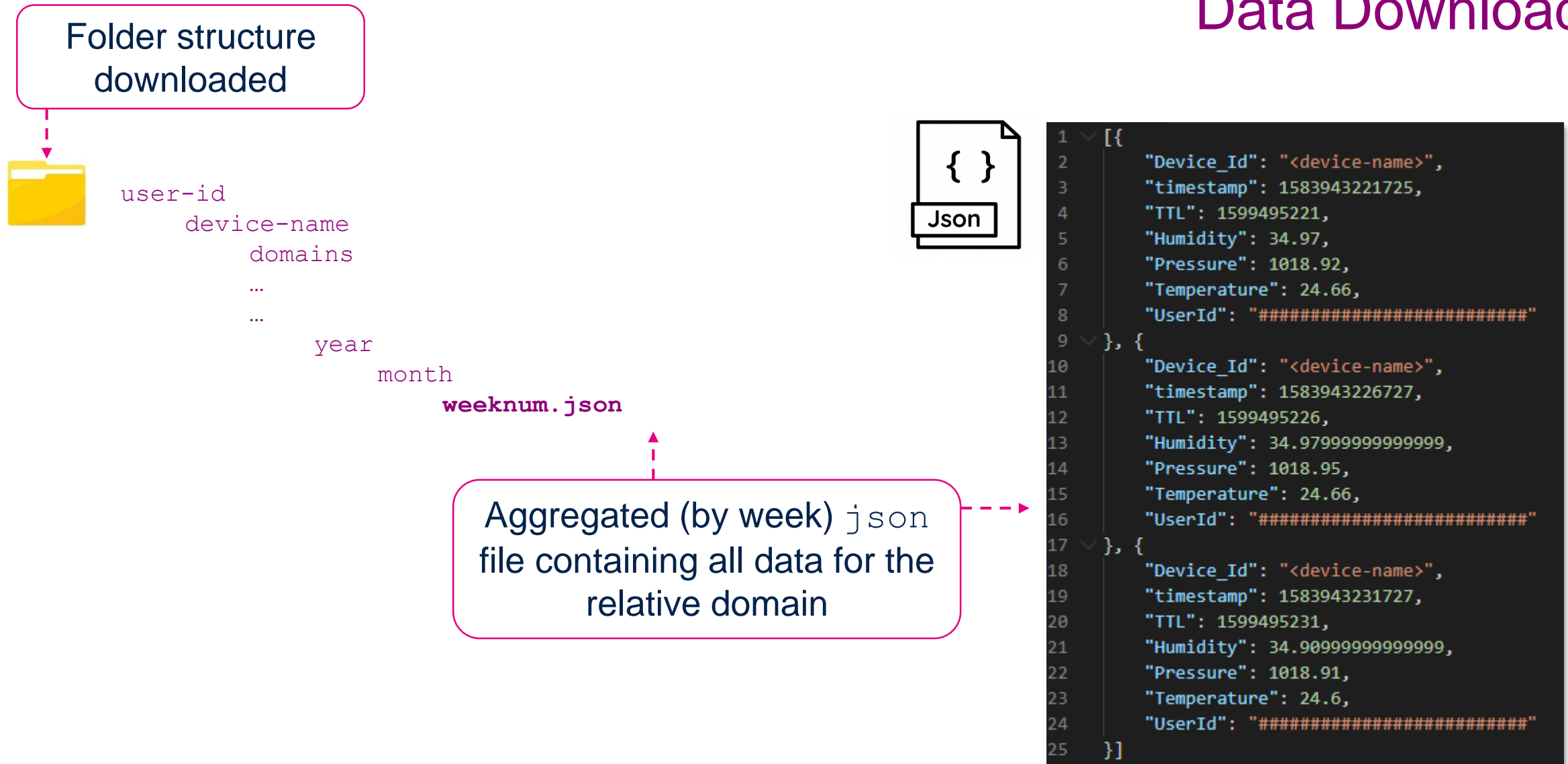
Click on the download button to execute the operation.

RESET DOWNLOAD

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Predictive Maintenance Dashboard

Data Download



Predictive Maintenance Dashboard

Data Download

Telemetry data
(environmental)

```
8  UserId : #####
9  }, {
10   "Device_Id": "<device-name>",
11   "timestamp": 1583943226727,
12   "TTL": 1599495226,
13   "Humidity": 34.97999999999999,
14   "Pressure": 1018.95,
15   "Temperature": 24.66,
16   "UserId": "#####"
```

Transmission
time

Predictive Maintenance Dashboard

Events

Events

Device Event type From To

☐ info ☐ warning ☐ alarm ☐ critical

[Last day](#) [Last week](#) [Last month](#) [Last 3 months](#)

REFRESH

TIMESTAMP	SEVERITY	DEVICE	INFORMATION
2020 Feb 21 11:37:43	INFO	STWIN_CES20B1	STWIN low power mode On
2020 Feb 21 11:26:09	INFO	STWIN_CES20B1	Bearing status OK
2020 Feb 21 11:26:03	ALARM	STWIN_CES20B1	Bearing ALERT fault detected
2020 Feb 21 11:26:03	WARNING	STWIN_CES20B1	
2020 Feb 21 11:25:59	INFO	STWIN_CES20B1	

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Entry point

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

Predictive Maintenance Dashboard

Events

Filters for advanced searching

The screenshot shows the 'EVENTS' tab of the Predictive Maintenance Dashboard. At the top, there is a navigation bar with tabs: CONFIGURATION, DASHBOARD, ASSETS CONDITION MONITORING, SENSOR MAP, and EVENTS (selected). A user profile icon labeled 'USERNAME' is on the right. Below the navigation bar, the 'Events' section features a filter area with 'Device' and 'Event type' dropdowns, and checkboxes for 'info', 'warning', 'alarm', and 'critical'. To the right of the filters is a 'Global statistics' gauge showing four levels: 70% info (blue), 20% warning (yellow), 10% alarm (red), and 0% critical (black). Below the filter area is a table of events with columns: TIMESTAMP, SEVERITY, DEVICE, and INFORMATION. The table lists five events for 'STWIN_CES20B1' on '2020 Feb 21'. The first event is 'INFO' at '11:37:43' with the message 'STWIN low power mode On'. The second is 'INFO' at '11:26:09' with 'Bearing status OK'. The third is 'ALARM' at '11:26:09' with 'Bearing ALERT fault detected'. The fourth is 'WARNING' at '11:26:09' with 'Bearing WARNING detected'. The fifth is 'INFO' at '11:26:09' with 'STWIN low power mode On'. At the bottom of the table is a pagination control with buttons for '<', '1', '2', and '>'. The footer of the dashboard includes a language selector 'EN', copyright information 'Copyright © 2019 - STMicroelectronics', and the version 'PREDMAINT 1.29.3'.

Events

Device Event type From To

☐ info ☐ warning ☐ alarm ☐ critical

[Last day](#) [Last week](#) [Last month](#) [Last 3 months](#)

70% info
20% warning
10% alarm
0% critical

TIMESTAMP	SEVERITY	DEVICE	INFORMATION
2020 Feb 21 11:37:43	INFO	STWIN_CES20B1	STWIN low power mode On
2020 Feb 21 11:26:09	INFO	STWIN_CES20B1	Bearing status OK
2020 Feb 21 11:26:09	ALARM	STWIN_CES20B1	Bearing ALERT fault detected
2020 Feb 21 11:26:09	WARNING	STWIN_CES20B1	Bearing WARNING detected
2020 Feb 21 11:26:09	INFO	STWIN_CES20B1	STWIN low power mode On

< 1 2 >

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Global statistics

Fast event identification

Paginations









Predictive Maintenance Dashboard

Send a command to NanoEdge™ AI library

1

CONFIGURATION DASHBOARD ASSETS CONDITION MONITORING SENSOR MAP EVENTS

DEVICES EDGE GATEWAYS

Type	Features	Firmware	Action
simulated		1.0	 
simulated		1.0	 
simulated		1.0	 
simulated		1.0	 

2

3

General
Add Device Information

Edge
Set device side events

Telemetry
Configure Streaming Time

Cloud
Set dashboard side events

Anomaly detection
Configure/Activate AI at edge

- 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**

Predictive Maintenance Dashboard

Send a command to NanoEdge™ AI library

STWIN_AGR01

COMMANDS SETTINGS

NanoEdgeAI lib sensitivity

1

Similarity threshold

90

CANCEL SAVE

1

STWIN_AGR01

COMMANDS SETTINGS

command to send

train_t

detect_t

Select a command to send to show the parameters

LAST COMMAND SENT

no command sent

CANCEL SEND

2

3

STWIN_AGR01

COMMANDS SETTINGS

command to send

train_t

COMMAND'S PARAMS

Training phase duration[ms]

10000

LAST COMMAND SENT

no command sent

CANCEL SEND

4

- 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

Predictive Maintenance Dashboard

Send a command to NanoEdge™ AI library

test123

COMMANDS SETTINGS

command to send
train_t

COMMAND'S PARAMS

Training phase duration[ms]
201

LAST COMMAND SENT

train_t 30/09/2021, 10:35:42
Training phase duration[ms]:201

CANCEL SEND

Use settings tab to change configuration parameters

test123

COMMANDS SETTINGS

NanoEdgeAI lib sensitivity Similarity threshold

1 90

CANCEL SAVE

See the information about the last command sent

Save parameters on the device

Detection phase of NanoEdge™ AI library

The diagram illustrates the detection phase of the NanoEdge™ AI library. It consists of three main components:

- COMMANDS Panel (1):** A web interface where a command to send is set to `detect_t`. The detection phase duration is set to 10000 ms. A pink arrow points from this panel to the NanoEdge device, labeled "Start detection".
- NanoEdge Device:** A physical device with a blue PCB and a blue case. An orange LED is blinking, indicated by a yellow arrow and the text "Orange led is blinking". A pink arrow points from the device to the dashboard, labeled "Alarm sent".
- Events Panel (2):** A dashboard showing an event. The event is an "ALARM" sent at "2021 Sep 15 15:12:10" from the device "stwin_prod". The event is categorized as "info", "warning", "alarm", or "critical". The dashboard also shows filters for "Device", "Event type", and "From/To" dates. A pink arrow points from the "Alarm sent" label to the event entry in the table.

TIMESTAMP	SEVERITY	DEVICE	INFORMATION
2021 Sep 15 15:12:10	ALARM	stwin_prod	Cartesia

- If the detect command is set, in accordance 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-IDP004V1/2
STSW-IDP4PREDMNT

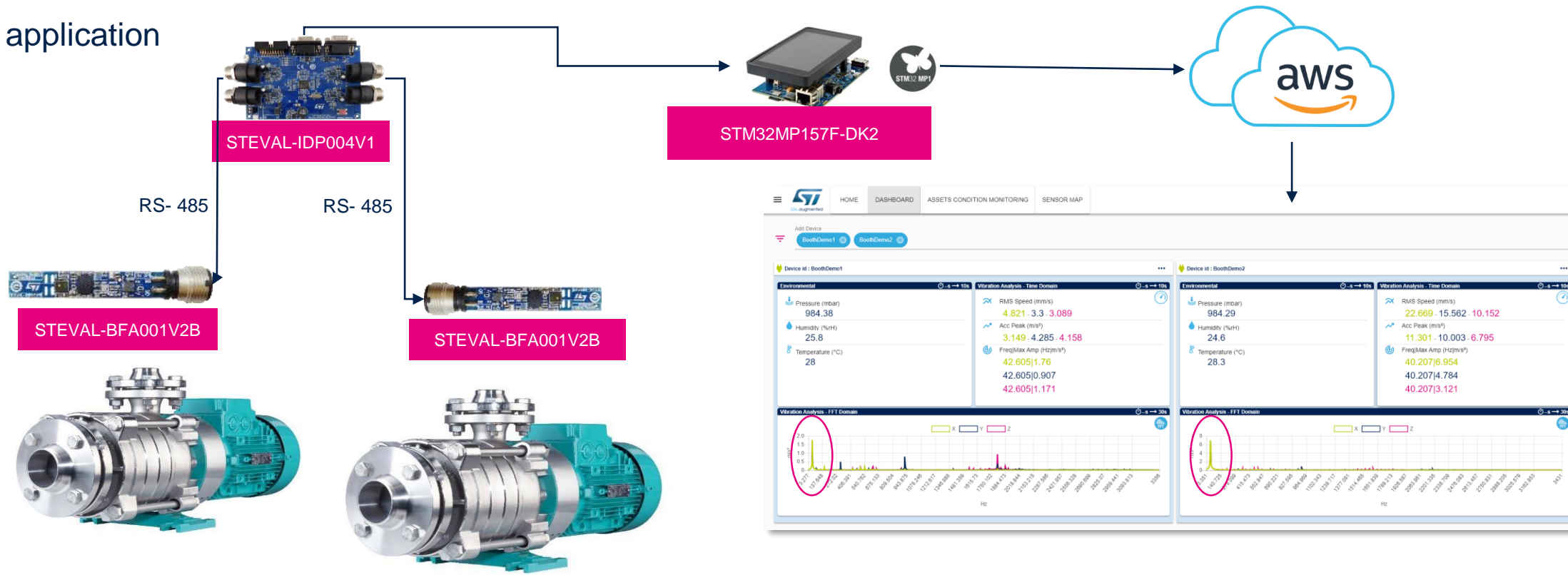
STEVAL-BFA001V1B
STSW-BFA001V1B

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



Vibration and Environmental Monitoring

Get the Hardware's, Download the SW

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

Buy the Hardware

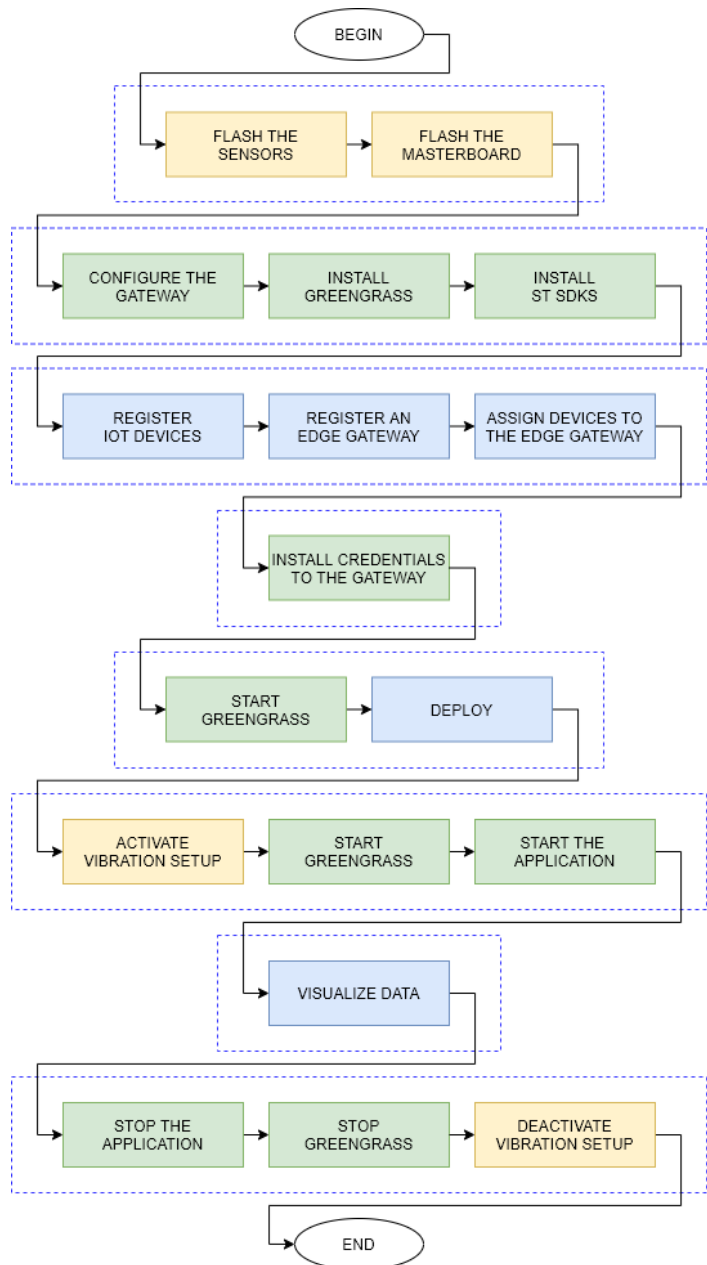
Component	Order code	Description
Smart Sensor Node	STEVAL-BFA001V2B	Predictive maintenance kit with sensors and IO-Link capability
Master	STEVAL-IDP004V1 STEVAL-IDP004V2	IO-Link master multi-port evaluation board
Gateway	STM32MP157F-DK2	Discovery kit with STM32MP157C MPU

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	

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



(1)
SENSORS AND
MASTERBOARD SETUP

(2)
GATEWAY
SETUP

(3.1)
DEVICE
PROVISIONING

(3.2)
INSTALL
CREDENTIALS

(3.3)
DEPLOYMENT

(3) APPLICATION SETUP

(4)
APPLICATION
START

(5)
CONDITION
MONITORING

(6)
APPLICATION
STOP

Legenda:



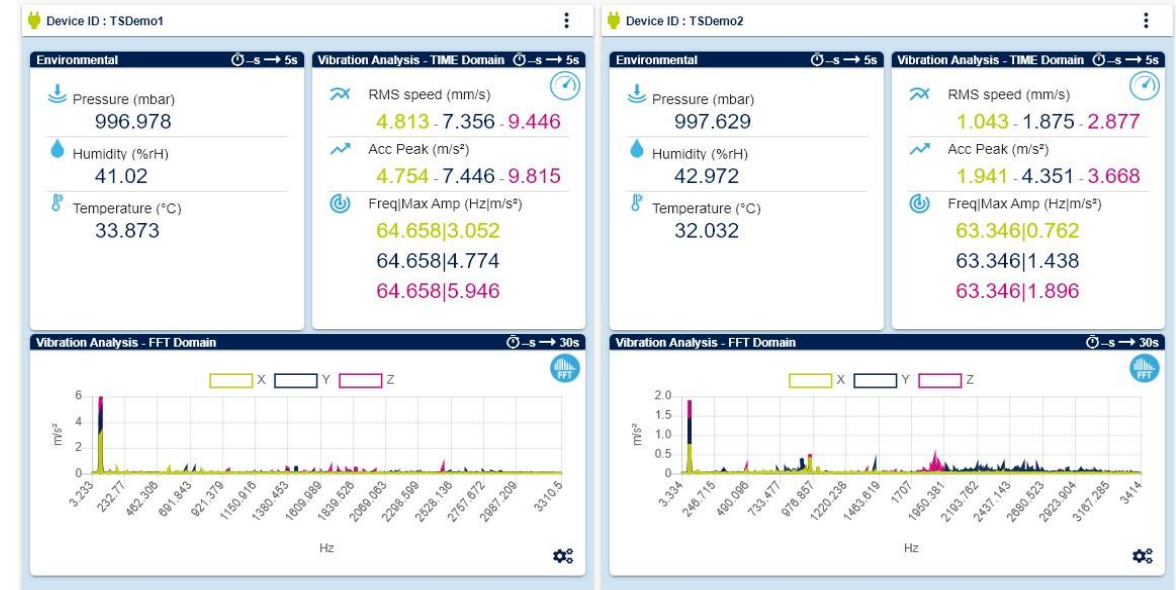
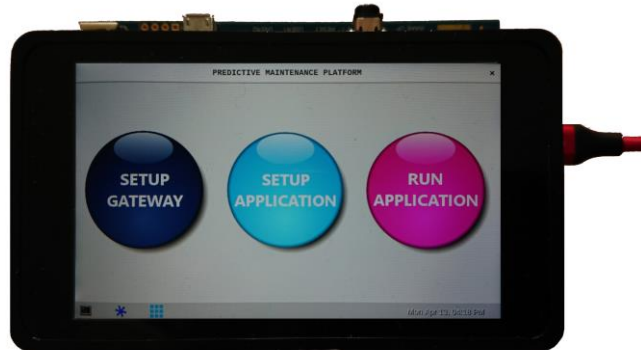
Vibration and Environmental Monitoring

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.



life.augmented

CONDITION MONITORING

Get started with SL-PREDMNT-S2C

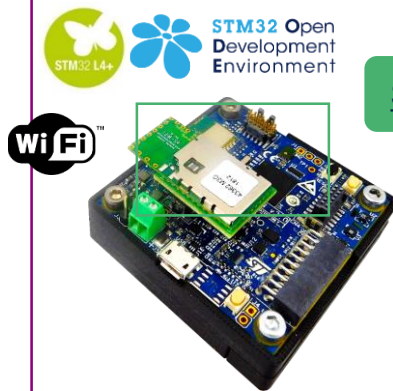
Predictive Maintenance Dashboard

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



STEVAL-STWINWVF1

STEVAL-STWINKT1B

FP-IND-PREMNT1

STEVAL-STWINKT1B



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

STSW-STWINCELL

Vibration and Ultrasound Monitoring

Quick Start with WIFI expansion STEVAL-STWINWF1

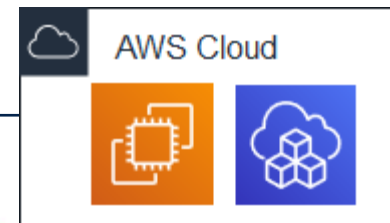
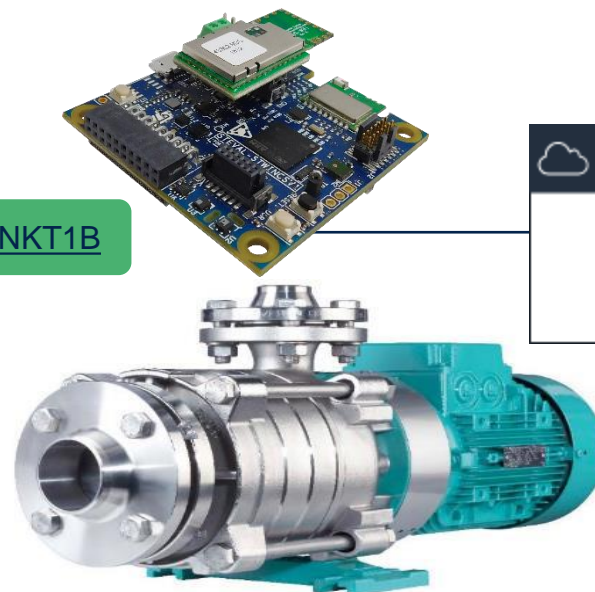
In this scenario a motor is monitored by using an STEVAL-STWINKT1B as smart sensor node connected by using the WIFI expansion module (STEVAL-STWINWFV1) and the smart sensor node is provisioned.

1. Get STEVAL-STWINKT1B and STEVAL-STWINWFV1
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



Timestamp	Severity	Device	Information
2020 Feb 21 11:37:43	INFO	STWIN_CES20B1	STWIN low power mode On
2020 Feb 21 11:26:09	INFO	STWIN_CES20B1	Bearing status OK
2020 Feb 21 11:26:03	ALARM	STWIN_CES20B1	Bearing ALERT fault detected
2020 Feb 21 11:26:03	WARNING	STWIN_CES20B1	Bearing WARNING detected
2020 Feb 21 11:25:59	INFO	STWIN_CES20B1	STWIN wake up

Vibration and Ultrasound Monitoring through WIFI

Get the Hardware, Download the Software

Buy the Hardware

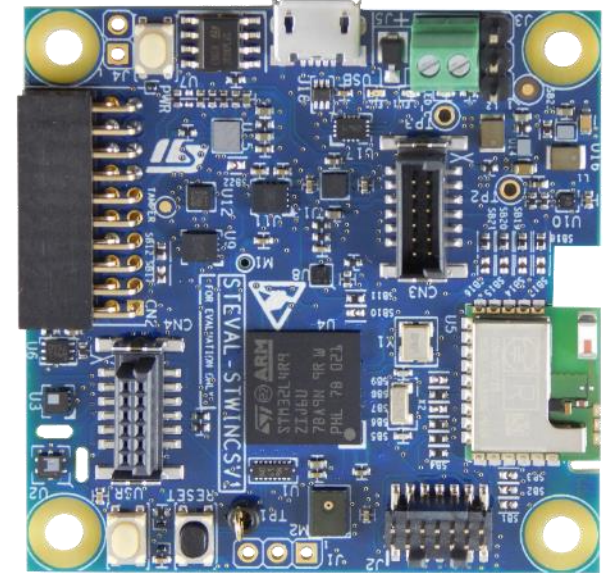
Component	Order code	Description
SensorTile Wireless Industrial Node (STWIN)	<u>STEVAL-STWINKT1B</u>	Predictive maintenance kit with sensors
Expansion board	<u>STEVAL-STWINWF1</u>	WIFI Expansion

Get the Software

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

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.



PWR

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

Name

_htmresc	
Documentation	← Docs
Drivers	← BSP, HAL and drivers
Middleware	← AWS, mbedTLS, Wifi, MotionSP
Projects	← Application example
Utilities	
package.xml	
Release_Notes.html	

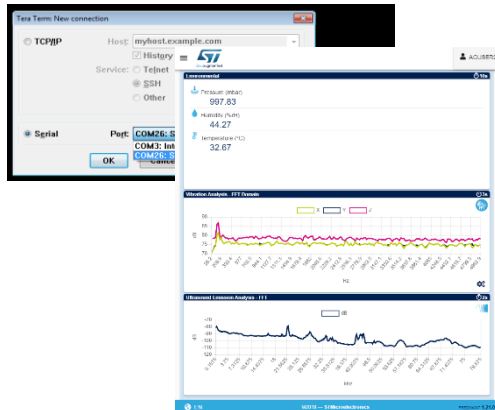
4



6

Configure and Monitoring the application

- TeraTerm (v. 4.97 or higher)
- ST DSH-PREDMNT



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

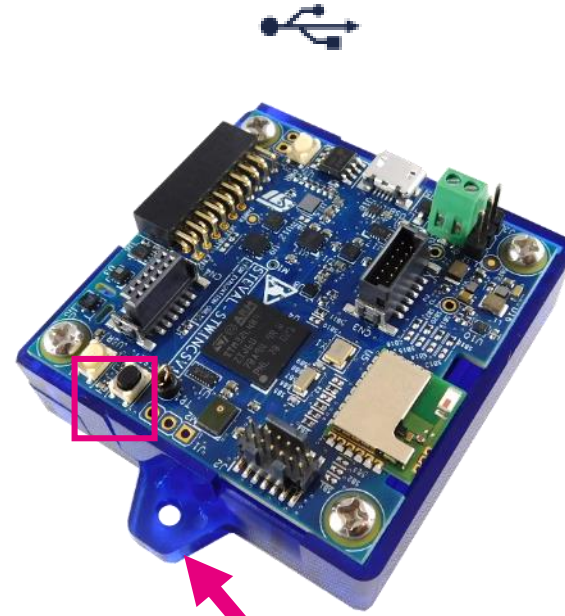
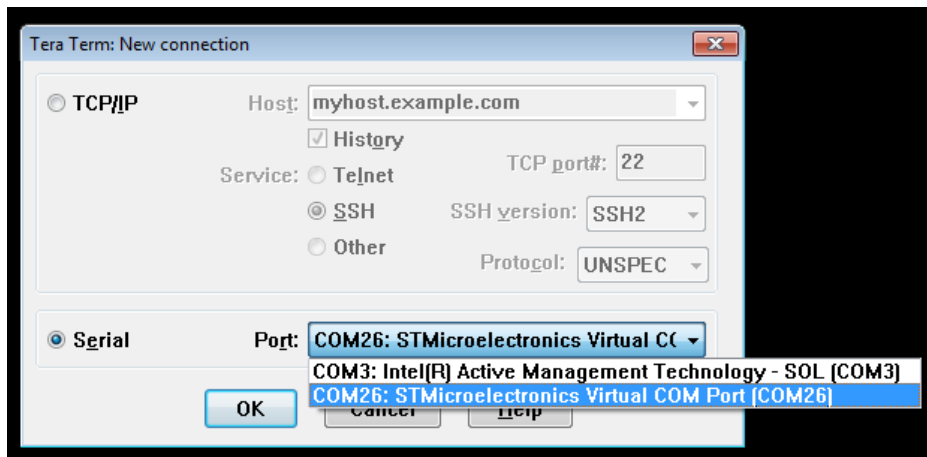
.\Projects\STM32L4R9ZI-STWIN\Demonstrations\Predictive_Maintenance_WIFI\AWS\Binary\STM32L4R9ZI-STWIN_PredictiveMaintenance_WIFI_v2.0.0.bin



Set up your network configuration

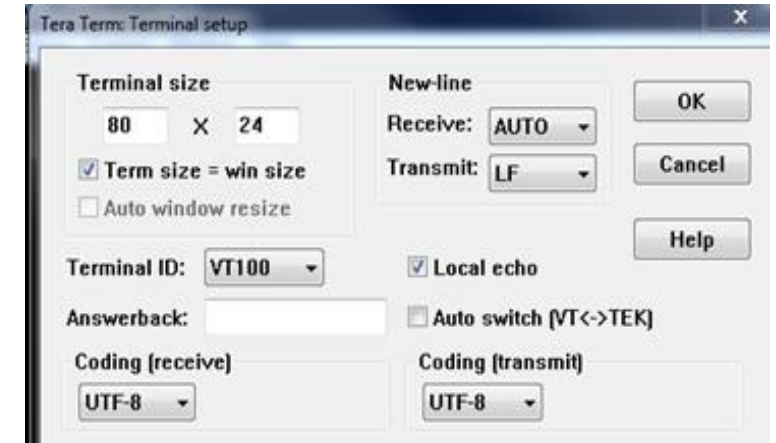
Predictive Maintenance Cloud Application (2/5)

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



Reset Button

- Setup->Terminal
 - Set parameters as below



- Press RESET button of STWIN.

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

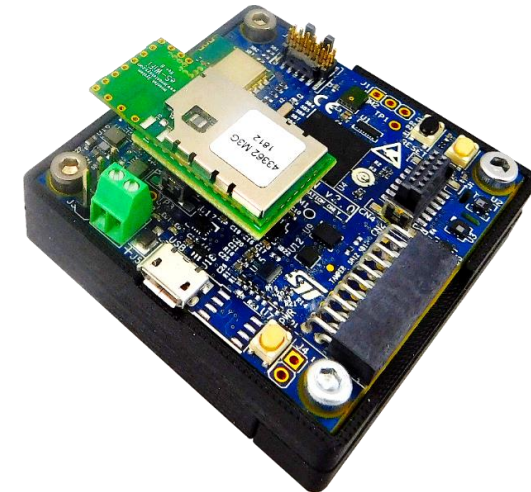
```
Push the User button (B3) within the next 5 seconds if you want to update the Wi
Fi network configuration.

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.

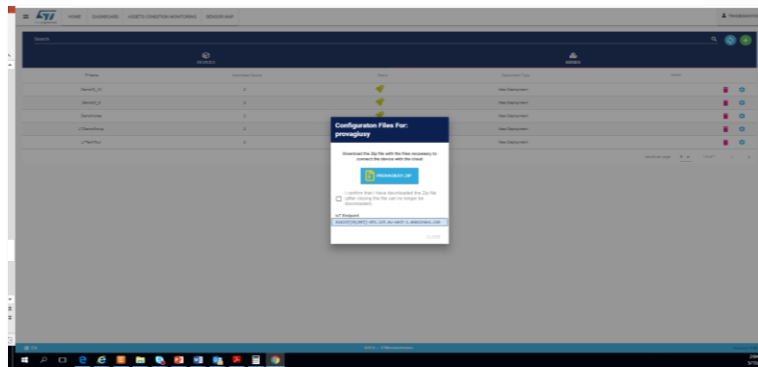
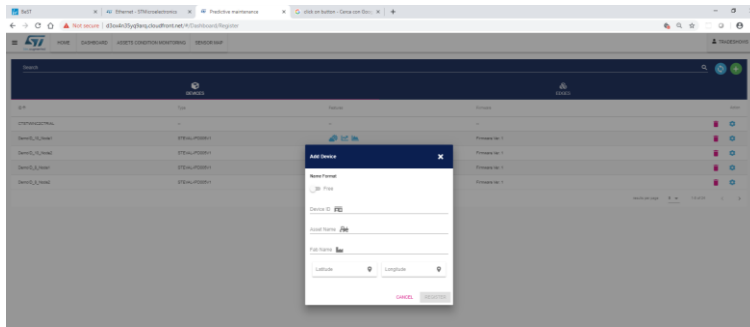
Enter password: f3f3f3f3
```



Register your node and inject data

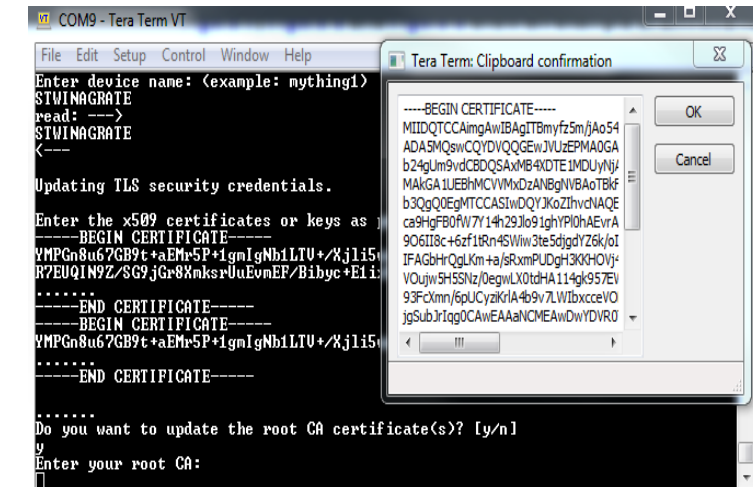
Predictive Maintenance Cloud Application (4/5)

1 Register and provision the device by downloading the certificates



2 Configure AWS Credentials and load the certificates

- Press the USB 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



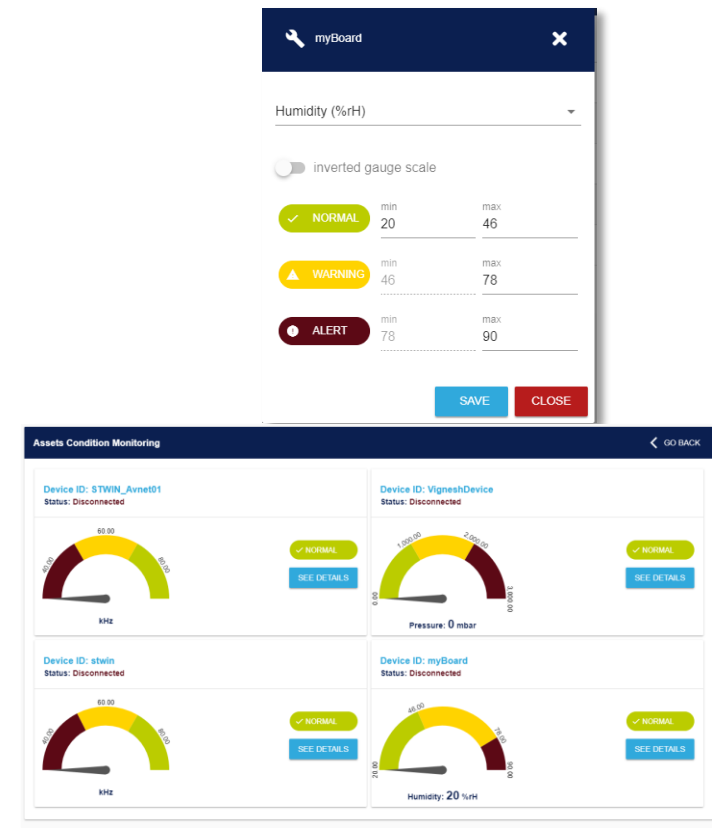
Start the application

Predictive Maintenance Cloud Application (5/5)

1 Add to the dashboard



2 Experiment thresholds

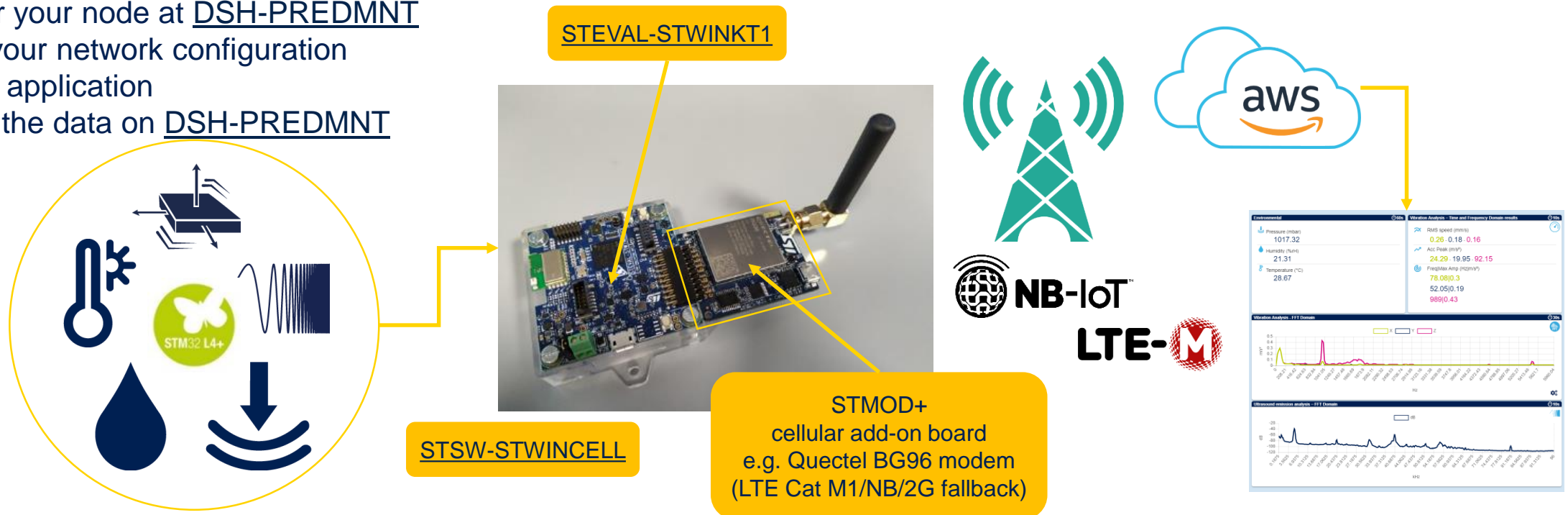


Vibration, Ultrasound and Environmental Monitoring

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



Vibration, Ultrasound and Environmental Monitoring

Get the Hardware, Download the Software

Buy the Hardware

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

Get the Software

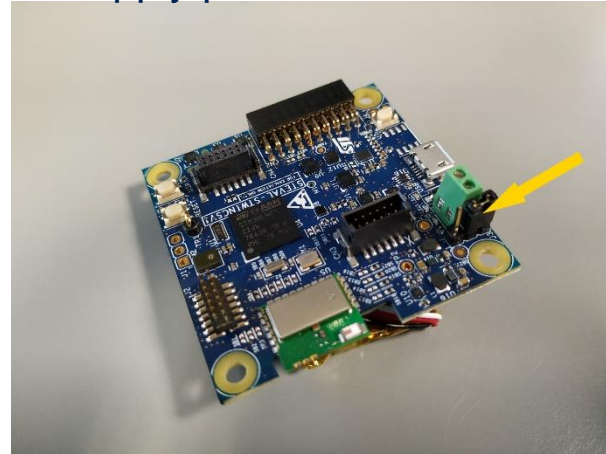
SW Layer Mission	Software Code	Online Distribution
Collect, Preprocess and communicate to the Cloud	<u>STSW-STWINCELL</u>	Binary and source code available for STM32
Visualize data	<u>DSH-PREDMNT</u>	Web based application

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

1 Connect the battery.



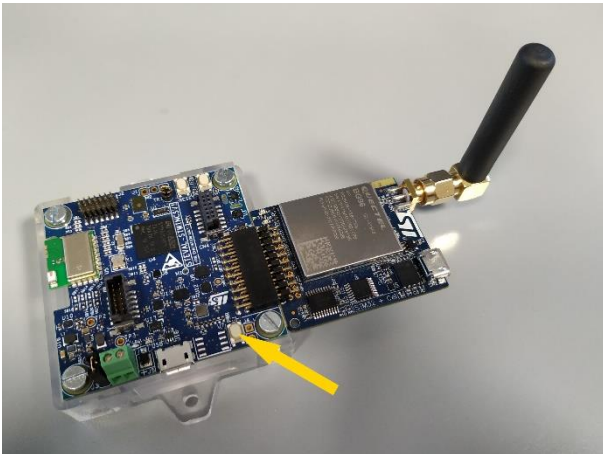
2 Route the right voltage to the power supply pin of the STMOD+ connector.



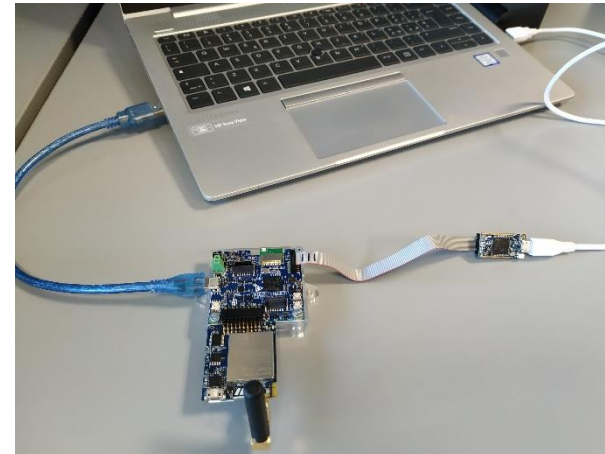
3 Insert the SIM card into the related socket of the STMOD+ cellular add-on board.



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



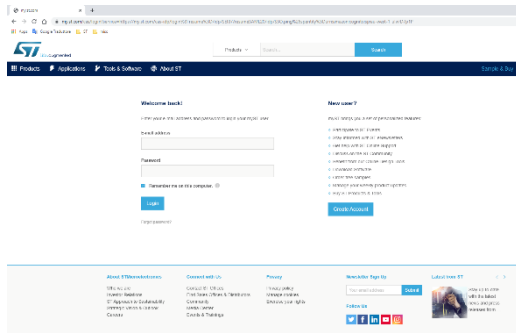
5 Power via USB receptacle and connect the STEVAL-STWINKT1B to a PC via the STLINK-V3MINI



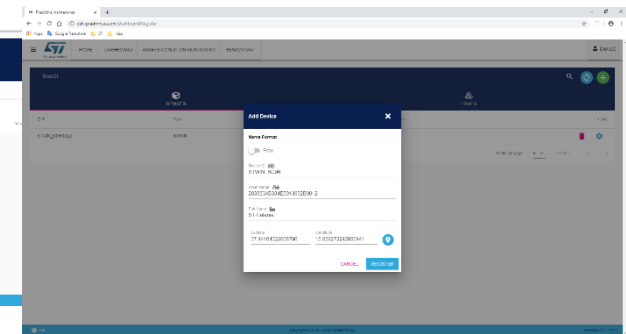
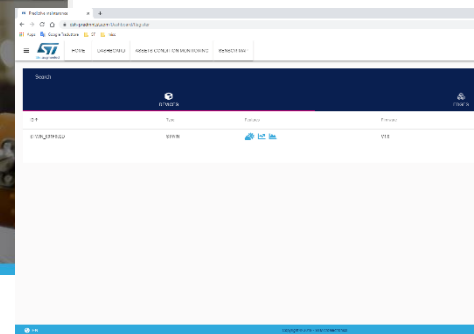
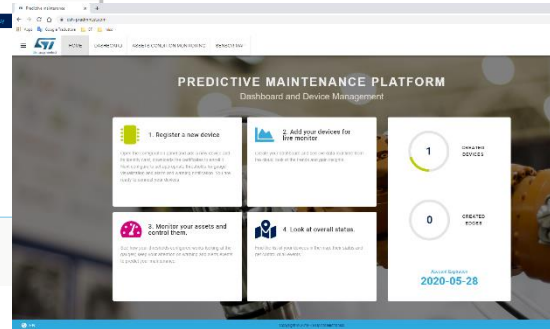
6 Download STSW-STWINCELL binary file into STEVAL-STWINKT1B's MCU

Log in to the dashboard and register the device

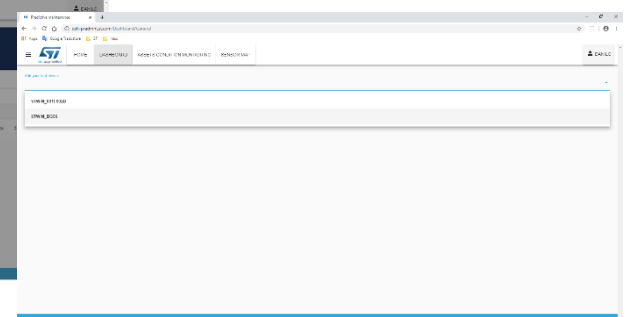
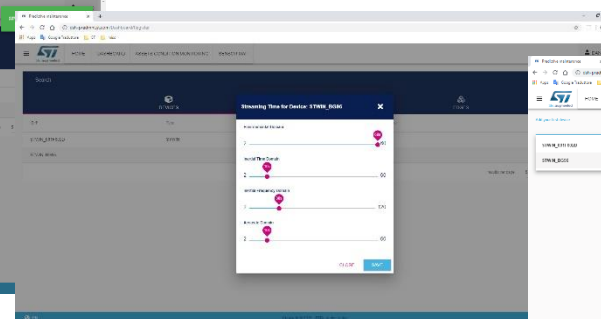
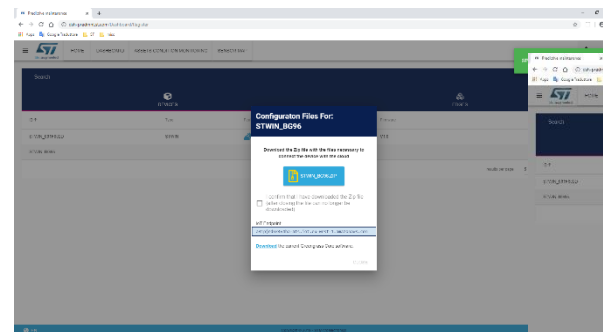
1 Sign Up or Sign In
(myST credentials)



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



3 Open the device's dashboard



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):
```

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.
```

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

```
- 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)
a31pjr6x4v4ba-ats.iot.eu-west-1.amazonaws.com
read: ----
a31pjr6x4v4ba-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+/Xj1i5ww0QuvfWu7uJBVCa0Ln0kcmnL
R7EUQIN9Z/SG9jGr8XmksrUuEvmEF/B1byc+El1xVA0hmnM3oTDPb5Lc9un8rNsu
.....
-----END CERTIFICATE-----
-----BEGIN CERTIFICATE-----
YMPGn8u67GB9t+aEMr5P+1gmIgNb1LTV+/Xj1i5ww0QuvfWu7uJBVCa0Ln0kcmnL
.....
-----END CERTIFICATE-----

.....
```

Enter your root CA:

```
Enter your root CA:
-----BEGIN CERTIFICATE-----
MKKDTCCA1mgAwKBAGKTBmyfz5m/jAo54vB4ikPm1jZbyjANBgkphkiG9w0BAQsF
ADA5MQswCQYDVQQGEwVUZEPMAG0A1UEChMGQW1hem9uMRkwFwYDVQDExBBwF6
b24gUm9vbCBBQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTE4MDExNzA1MDAwMFowTEL
MAKGA1UEBhMCVVMxZDANBgNVBAoTBkFtYXpvcjE2MzBcGA1UEAxMQQW1hem9uKFWv
b3QgQ0EgMTCCASKwDQYwKoZKhvcNAQEBAQggEPADCCAQoCggEBALW4gHHKcXNj
```

Enter your device certificate:

```
-----BEGIN CERTIFICATE-----
MKKDWjCCAKKgAwKBAGKVAKPwPbT8X6wzi0Y4z0pX19T7aU5owMA0GCSpGSKb3DQEB
CwUAME0xSzBWBqNVBAsMQkFtYXpvcjE2MzBcGA1UEAxMQQW1hem9uKFWv
KE1uYy4gTD1TZWF0bGx1kFNUPVbhc2hpbm0b24gQz1VUzAeFw0yMDAxMDQxNTU5
NDZaFw00TEYmZyMzU5NT1aMB4xHDAaBgNVBAMME0FtYXpvcjE2MzBcGA1maWwN
bGUwggEiMA0GCSpGSKb3DQEBAAUAA4KBDwAwggEKAoKBAQCTM1MNC651mpVE58v0
```

Enter your device key:

```
-----BEGIN RSA PRIVATE KEY-----
MKKEowKBAAKCAQEAptNTDQuubZpVR0fL9DS+BNQY91P7shGzzaD1cSDaW4pQcB1
jgzIALSaGwhBpLW4K0hFR1DZyWk5pnfAp/Tg9F233fuya55ZmBL8CMWryLsFN00
Cy7X/0g3pup/QGNURxX3Abpvx6TWf2EjNut6Zt9WMMWY0nTPrzADizfDpuBCVi9
p1bFkp/71ZPk1WFEOkFHWgsMvN4uvikp6ZQ+U5tjyZgHEFyb7fkaNTzBt/Sn0FW
jKOPSh2SvMLtcgz0ukk+b0BSstEfb6kvUS9PpkrnpF2bmKPL3xf0234YhsbbM1RA
```



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 a31pjd6x4v4ba-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,-73.7300000000000000,-72.53,-73.92,-76.33,-79.17,-78.39,-  
76.7,-77.5400000000000000,-81.15,-83.7900000000000000,-83.069999999999991,-81.3400000000000000,-  
80.6800000000000000,-81.61,-83.659999999999991,-84.65,-82.519999999999991,-79.94,-80.86,-84.02,-  
86.13,-84.57,-82.0900000000000000,-81.87,-83.81,-85.91,-85.98,-83.569999999999991,-  
83.1800000000000000,-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],[311.48,0.01,0.01,  
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],
```

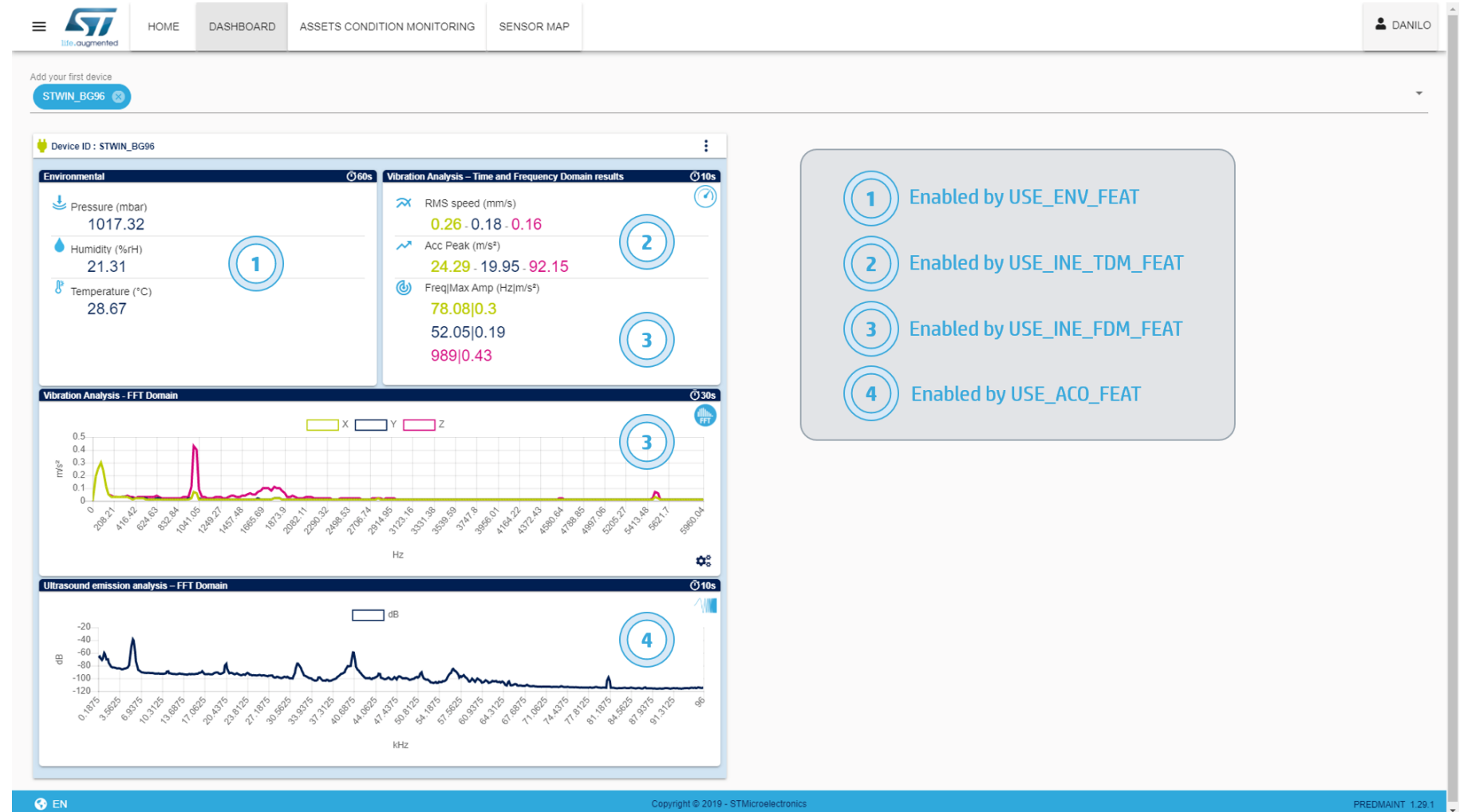


Populated ST Predictive Maintenance Dashboard while running STSW-STWINCELL

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

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

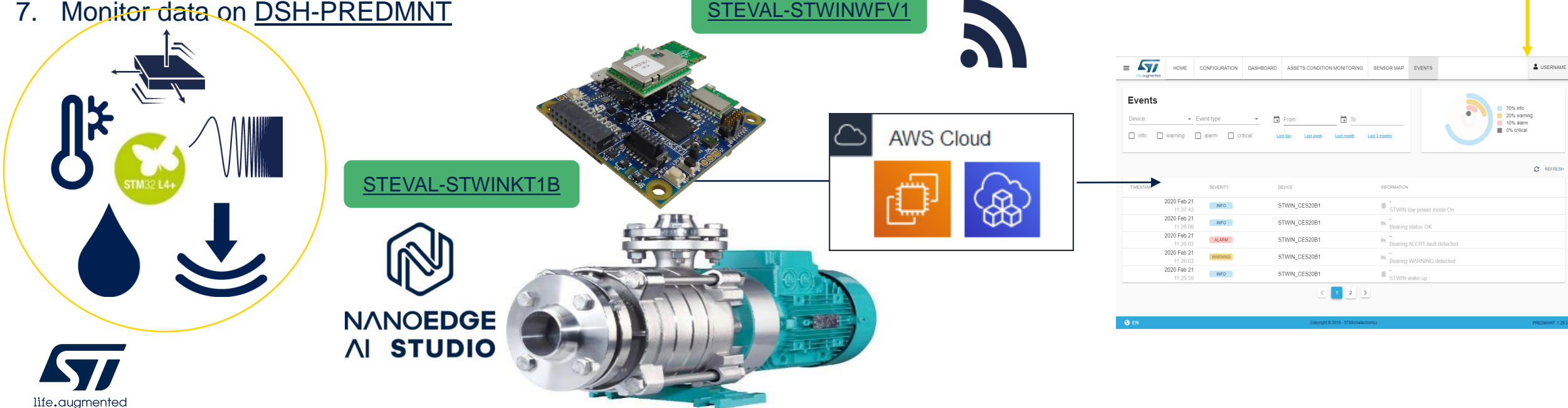


Anomaly Detection with NanoEdge AI Studio

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-STWINWFV1
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



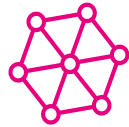
Setup a NanoEdge™ AI library into FP-AI-PREDMNT2

Generating contextual data using
FP-SNS-DATALOG1

Build library using
NanoEdge™ AI Studio

Embed and use into
FP-AI-PREDMNT2

Capture data



Accelerometer

1

Label data



Normal

Anomaly

2

Build
NanoEdge Lib



Modeling

Results

3

Embed
NanoEdge Lib



NanoEdge
integration

NanoEdge
implementation

4

Process
new data



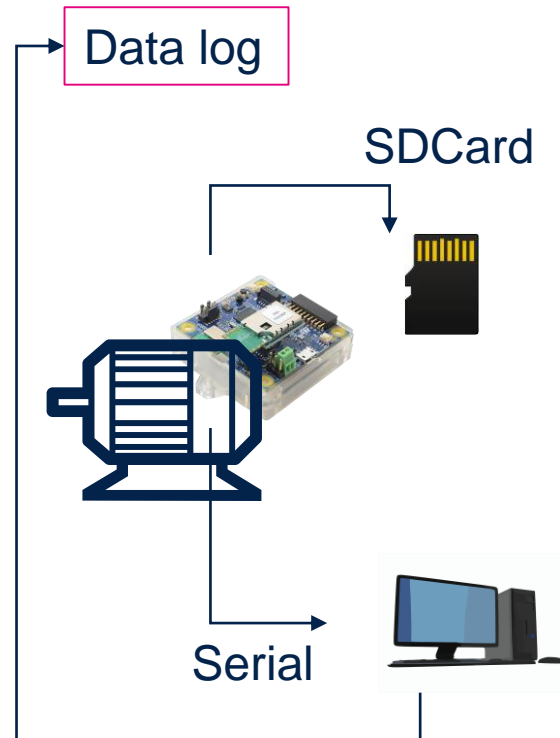
Real-time
learning

5

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

Setup & Demo Examples

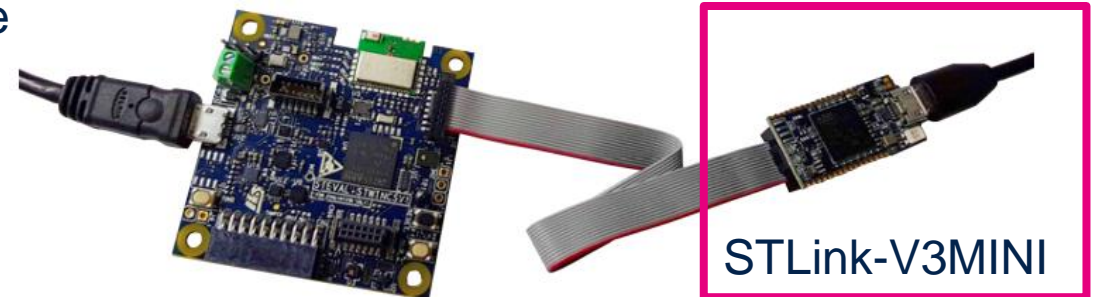
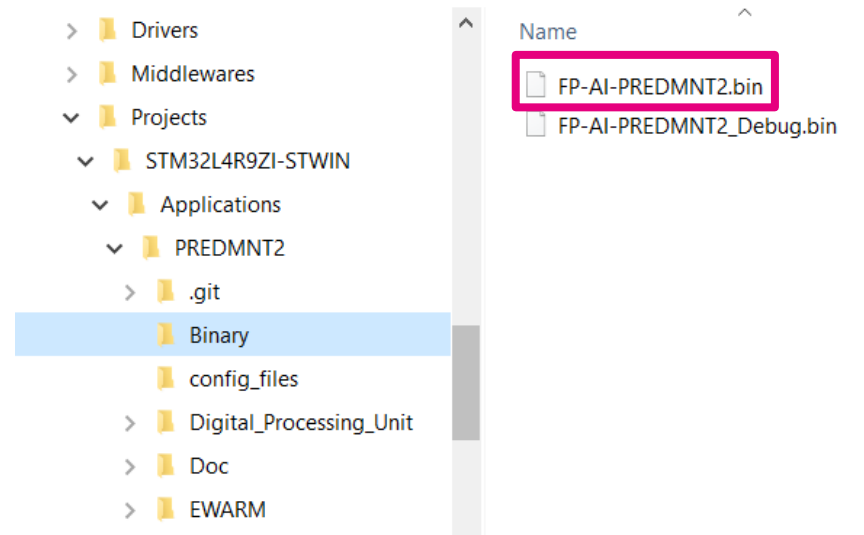
Firmware update

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**

FP-AI-PREDMNT2

Setup Overview



1 www.st.com/stm32code-fp

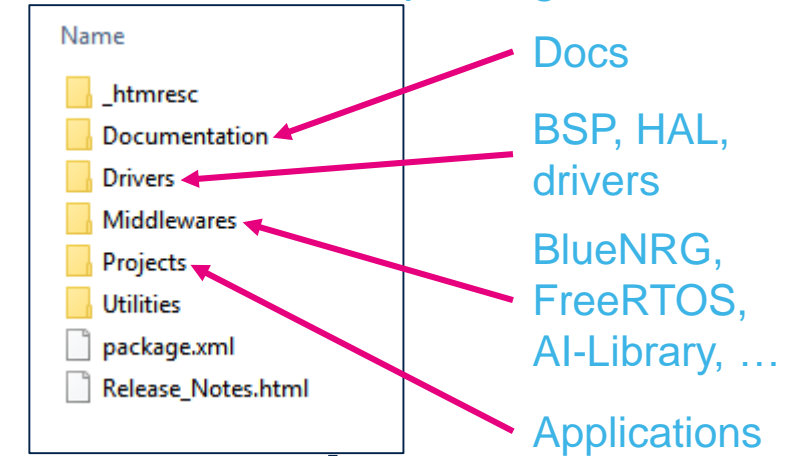
2



3
Download & unpack

Select Function Pack: FP-AI-PREDMNT2

FP-AI-PREDMNT2 package structure



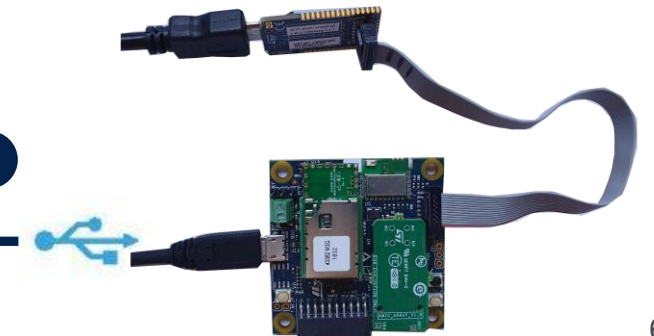
4

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

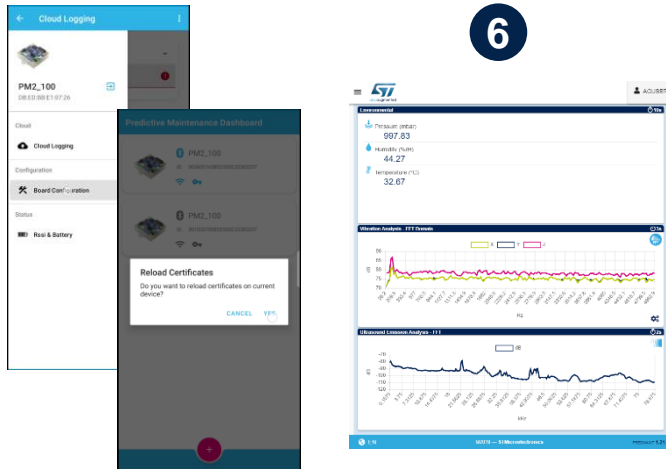
Projects\STM32L4R9ZI-STWIN\Applications\PREDMNT2\



5



6



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_NANOEDGE1/Middlewares/Third_Party/Cartesiam_NanoEdge_AI_Library/

Name

Inc	
lib	NanoEdgeAI.h
	Libneai.a



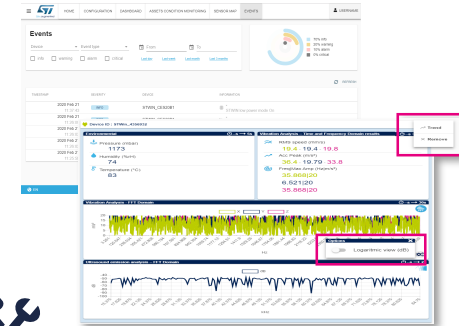
5 Re-compile the FP

6 NanoEdge Learn



NanoEdgeAI_learn()

7 Run the demo: NanoEdgeAI execute



NanoEdgeAI_execute()

Detection phase of NanoEdge™ AI library

1 Start detection

Orange led is blinking

2

Alarm sent

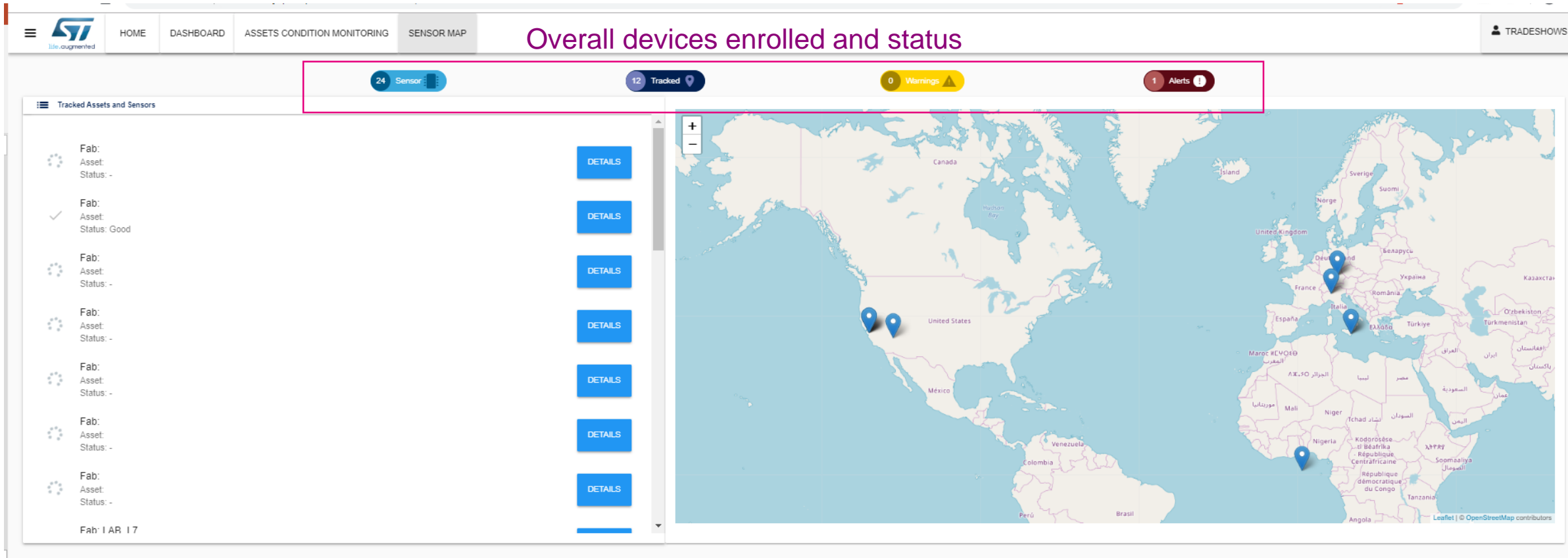
The 'Events' panel shows a table with the following data:

TIMESTAMP	SEVERITY	DEVICE	INFORMATION
2021 Sep 15 15:12:10	ALARM	stwin_prod	Cartesia

- If the detect command is set, in accordance 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](#).

Predictive Maintenance Dashboard

Register other devices and get the Full Picture



Assets and Status

Geo localization

Thank you

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