UM2639

User manual

How to use the STM32 MPU OpenSTLinux expansion pack for predictive maintenance

Introduction

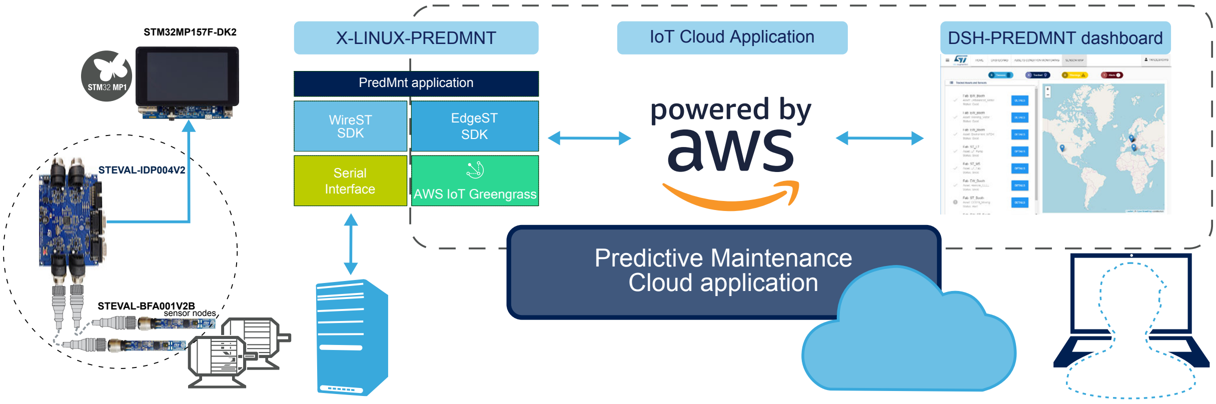
The STM32 MPU OpenSTLinux Expansion Pack for Predictive Maintenance enables the development of Edge processing applications. It forms an end-to-end solution with corresponding hardware to allow environmental and inertial data from industrial equipment to be sent to an IoT application with dedicated dashboard for data analysis and identification of conditions that might require immediate or future maintenance intervention.

The application helps users manage many of the critical aspects of effective condition monitoring with remote IoT sensor nodes, such as registering remote devices, configuring gateways, and connecting to IoT cloud services. In particular, it interfaces with the Amazon AWS IoT cloud and uses the AWS IoT Greengrass Edge Computing service on the gateway to run local logic and transmit data seamlessly, even under conditions of intermittent Internet connectivity.

The development hardware for the application includes a vibration kit with motors, STEVAL-BFA001V2B IO-Link sensor boards with inertial measurement unit, various environmental sensors plus on-board MCU for sensor data computation and management, and the STEVAL-IDP004V2 IO-Link master board. A gateway node is set up with the STM32MP157F-DK2 discovery kit featuring various wired and wireless connectivity solutions, SD card data storage, LCD touch screen interface and appropriate high performance STM32MP1 series microprocessor.

The edge gateway collects environmental and FFT data from accelerometer sensors, which are then sent via MQTT over Ethernet or Wi-Fi to a dashboard based on the AWS infrastructure.

Figure 1. **Condition monitoring and Edge to Cloud: from sensors to gateway to cloud dashboard**



1 Edge processing application overview

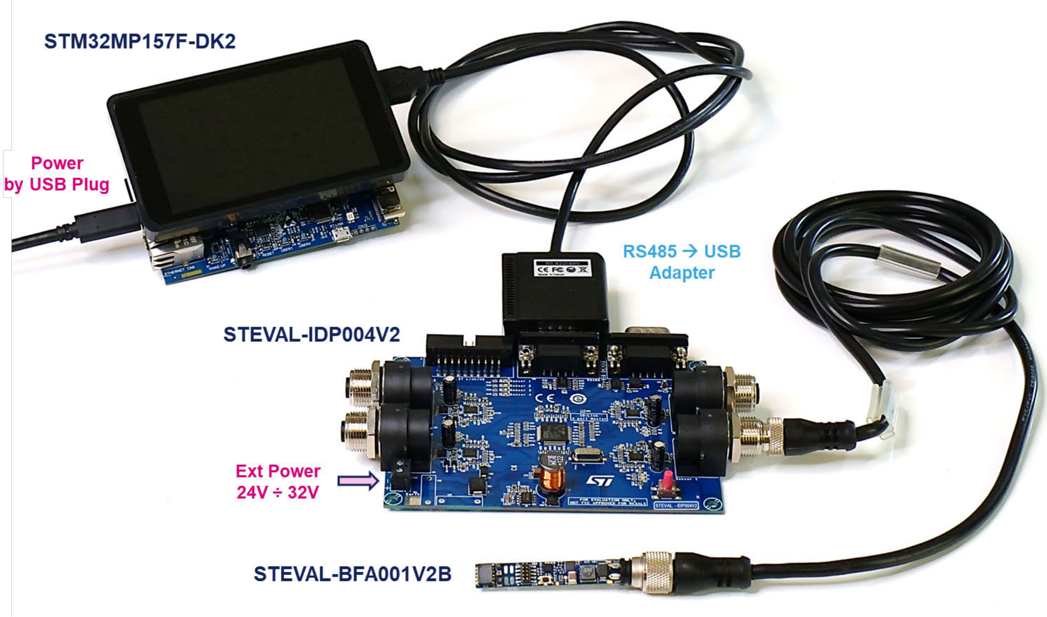
For the edge processing application setup, you need the following elements:

- Gateway node:
  - STM32MP157F-DK2 discovery kit with a minimum 4GB SD card
- Smart sensors and Master hardware:
  - master board: STEVAL-IDP004V2
  - sensor boards: STEVAL-BFA001V2B kit
- myST account for the Edge Processing Application dashboard.
- PC with the STM32 ST-LINK Utility and ST-LINK Programmer (standalone or integrated in STM32 Nucleo boards).
- Internet connection with no proxy nor firewall.

The figure below shows how to build correctly the solution using all the boards mentioned above plus an RS-485-to-USB adapter to connect the master and MP1.

The solution can start connecting the MP1 gateway to the cloud, using wired or Wi-Fi connectivity.

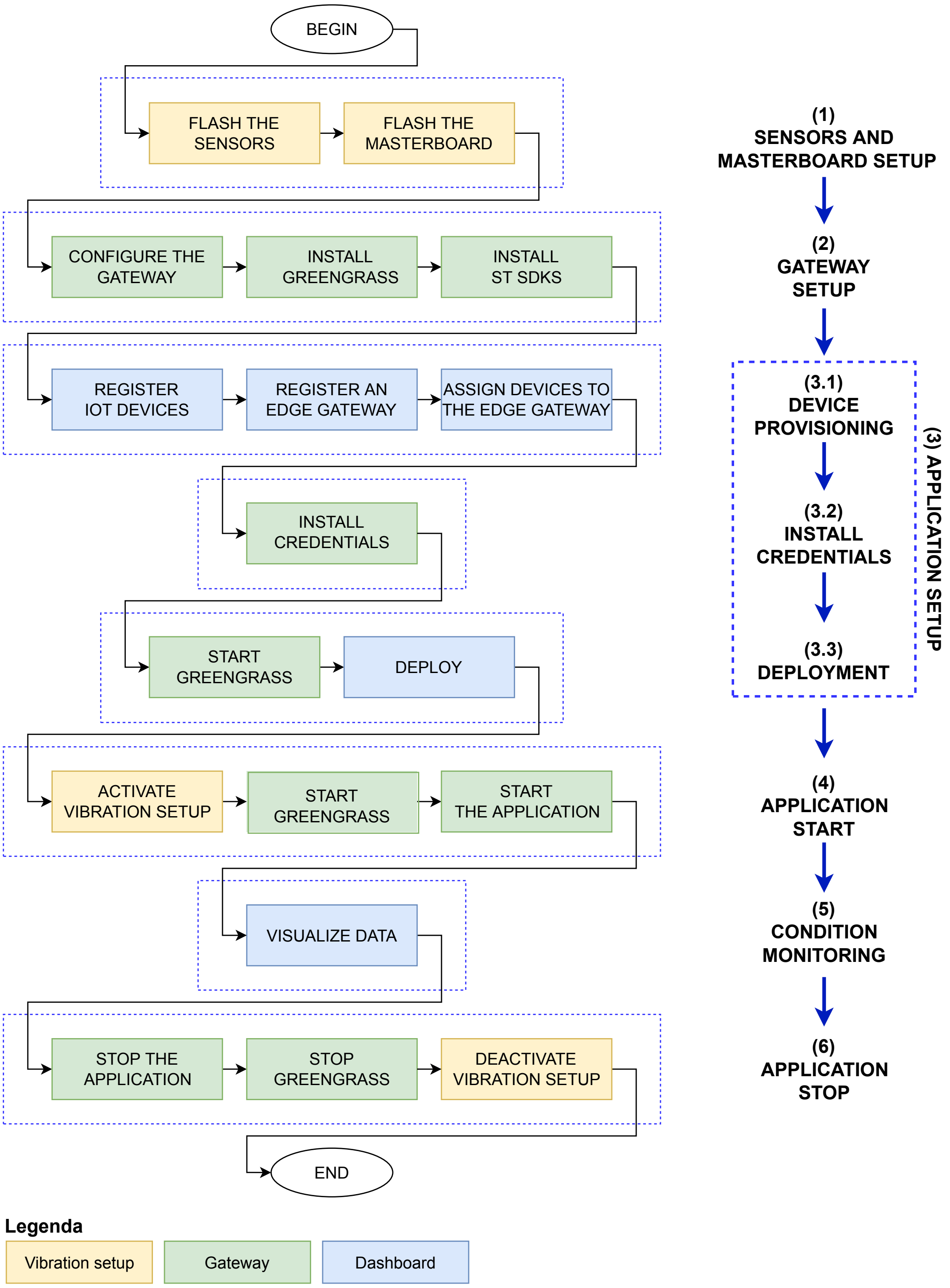
Figure 2. SL-PREDMNT-E2C solution setup



2 Edge Processing Application setup and operation

The flow chart below provides an overview of the procedure involved in setting up and running the application.

Figure 3. Setup and operation



2.1 Sensor and master board setup

Follow the procedure below to flash the sensor board and the master board with the latest firmware.

Step 1. Download the binary files for the sensor and master boards from the following locations on the ST website:

– Sensor node: STSW-BFA2PREDMNT available at STSW-BFA001V2

– Master board: STSW-IDP4PREDMNT

Step 2. Flash the relevant binaries onto the STEVAL-IDP004V2 IO-Link master board and STEVAL-BFA001V2B IO-Link sensor boards.

Use the STM32 ST-LINK (STSW-LINK004) Utility and an appropriate ST-LINK programmer/debugger device (standalone or integrated in STM32 Nucleo boards).

2.2 Gateway setup

The current solution is based on the following software:

- STM32MP15-Ecosystem-v2.1.0 (openstlinux-5.4-dunfell-mp1-20-11-12)
- Amazon AWS IoT Greengrass Core Software v1.11.0
- Python 3.8.2

The instructions provided in this chapter can be similar and work even for newer distributions of the STM32MP15-Ecosystem-v2.1.0.

To set up an STM32MP157F-DK2 discovery kit as the Edge gateway for your Predictive Maintenance Platform, you can either:

- Flash a preconfigured image by ST:
  – X-LINUX-PREDMNT
- Create and flash a custom image

Figure 4. STM32MP157F-DK2 discovery kit

STM32 MPU with dual-core Cortex-A7 CPU, 800 MHz GPU, and Cortex-M4 MCU
Secure boot and cryptography, LCD, Wi-Fi, Bluetooth low energy

Important: *Set the micro-switches to OFF before flashing and to ON just after.*

RELATED LINKS

You can use this free tool to master your binary images onto an SD card

Visit the STM32 MPU wiki page for relevant guides and resources regarding the STM32 MPU

2.2.1 How to create an image for the STM32MP1 discovery kit

Follow the instructions below to configure an STM32MP157F-DK2 discovery kit as a Linux gateway.

Note: The instructions apply to the STM32MP1 DK2 C01 and C2 releases only.

Step 1. Set up your host environment according to the PC prerequisites page at the STM32 MPU wiki page:
https://wiki.st.com/stm32mpu/wiki/PC_prerequisites

Step 2. If this is the first use of the Discovery board, install the Starter Package and flash the image to an empty SD card so that all the partitions are created:
https://wiki.st.com/stm32mpu/wiki/STM32MP15_Discovery_kits_-_Starter_Package

Important: Set the micro-switches to OFF before flashing and to ON just after.

Step 3. Get the distribution package as described in the following wiki page:
https://wiki.st.com/stm32mpu/wiki/STM32MP1_Distribution_Package

Step 4. Follow the instructions up to and including the command to build the image:

```
bitbake st-image-weston
```

Note: Whenever running a "bitbake" instruction, you might end up with an error like this:

```
ERROR: No space left on device or exceeds fs.inotify.max_user_watches?
 ERROR: To check max_user_watches: sysctl -n fs.inotify.max_user_watches.
 ERROR: To modify max_user_watches: sysctl -n -w
fs.inotify.max_user_watches=<value>.
 ERROR: Root privilege is required to modify max_user_watches.
```

In this case, run the following command:

```
sudo sysctl -n -w fs.inotify.max_user_watches=32768
```

Increase the value by powers of "2" in case you continue getting an error.

Reboot and repeat the "bitbake" instruction; repeat the workaround in case you continue getting an error.

The image file is included in the distribution package.

Step 5. Move to the <layers> directory and install the *meta-predmnt* layer, available here:
https://github.com/STMicroelectronics/meta-predmnt

This layer contains the recipes to install the Predictive Maintenance application, the Amazon AWS IoT Greengrass service for edge computing (https://aws.amazon.com/it/greengrass/), and other required Python packages (view meta-predmnt/conf/layer.conf file for further details):

```
cd <path-to>/openstlinux-<version>/layers
```

```
git clone https://github.com/STMicroelectronics/meta-predmnt
```

```
cd <path-to>/openstlinux-<version>/build-openstlinuxweston-stm32mp1/conf/
```

Step 6. Copy and paste the following line into the bblayers.conf file, just before the BBLAYERS token definition, and check that the BBLAYERS token contains the FRAMEWORKLAYERS token, otherwise add it:

```
FRAMEWORKLAYERS += "${@'${OEROOT}/layers/meta-predmnt' if os.path.isfile('${OEROOT}/
layers/meta-predmnt/conf/layer.conf') else ''}"
```

Step 7. Move to the <openstlinux> directory, enable the USB support in the kernel, and build:

```
cd <path-to>/openstlinux-<version>
```

```
bitbake virtual/kernel -c menuconfig
```

Step 7a. Navigate to [**Device Drivers**] and to [**USB support**].

Step 7b. Place a check on the following entry by pressing the [**Space**] key until an asterix (*) character appears and then press enter:

```
USB Serial Converter support
```

Step 7c. Place a check on the following entries by pressing the [**Space**] key until an asterix (*) character appears and then press enter:

```
USB Serial Console device support
```

```
USB Generic Serial Driver
```

```
USB Serial Simple Driver
```

```
USB FTDI Single Port Serial Driver
```

Step 7d. Save and exit:

```
bitbake virtual/kernel
```

Step 8. Move to the <openstlinux> directory, and build the image (same instructions described in the Distribution Package page):

```
cd <path-to>/openstlinux-<version>
```

```
DISTRO=openstlinux-weston MACHINE=stm32mp1 source layers/meta-st/scripts/envsetup.sh
```

```
bitbake st-image-weston
```

Step 9. Move to the <image> directory, and flash the image (same instructions described in the Starter Package page):

Important: *Set the micro-switches to OFF before flashing and to ON just after.*

```
cd <path-to>/openstlinux-<version>/build-openstlinuxweston-stm32mp1/tmp-glibc/
deploy/images/stm32mp1
```

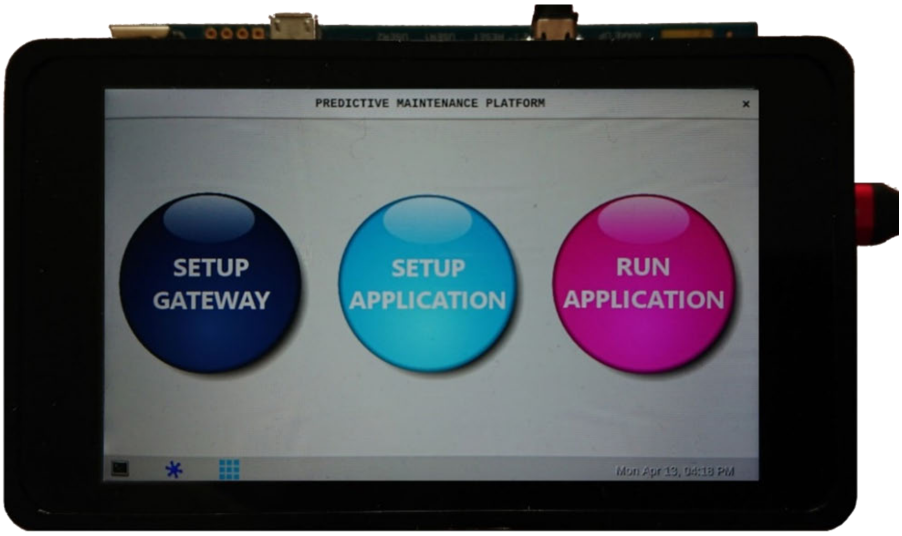
```
STM32_Programmer_CLI -c port=usb1 -w flashlayout_st-image-weston/
FlashLayout_sdcard_stm32mp157c-dk2-trusted.tsv
```

2.2.2 How to configure the gateway

Important: *Set the micro-switches to ON before turning the gateway on.*

Step 1. Turn the gateway ON and wait for the Main GUI to appear.

Figure 5. **Gateway Main GUI**



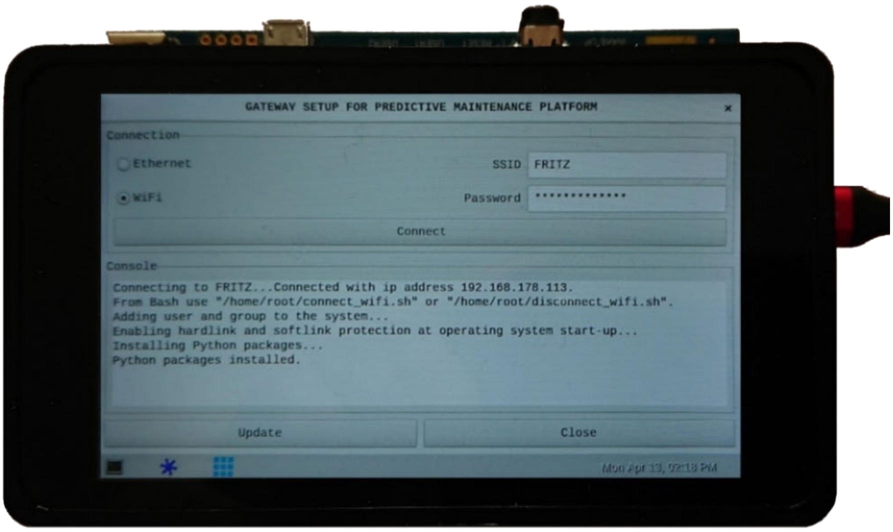
The Main GUI can also be started via the following command:

```
/usr/local/predmnt/start.sh --gui
```

Step 2. Complete the gateway setup by clicking on the [**SETUP GATEWAY**] button.

The following panel appears to allow you to configure and connect the gateway to a Wi-Fi network or to the Internet through an Ethernet cable.

Figure 6. **Gateway GUI setup**



○ Ethernet
● WiFi
SSID FRITZ
Password *************

```
Connecting to FRITZ...Connected with ip address 192.168.178.113.
From Bash use "/home/root/connect_wifi.sh" or "/home/root/disconnect_wifi.sh".
Adding user and group to the system...
Enabling hardlink and softlink protection at operating system start-up...
Installing Python packages...
Python packages installed.
```

Step 3. Click on the [**Update**] button to install or update the following libraries:

- Amazon AWS IoT Python SDK: https://github.com/aws/aws-iot-device-sdk-python
- WireST-SDK: https://github.com/STMicroelectronics/WireSTSDK_Python
- EdgeST-SDK: https://github.com/STMicroelectronics/EdgeSTSDK_Python
- Other Python packages (pyserial)

2.2.3 How to connect to the gateway via SSH

Once the gateway is connected to a network:

Step 1. Retrieve its IP address from a terminal on the gateway with the command below:

```
ifconfig
```

Step 2. Connect to the gateway from another device via SSH by running the following command (you have to use “root” for the user on the “openstlinux” distribution):

```
ssh <user>@<IP-ADDRESS>
```

2.2.4 How to reboot and turn the gateway off

Step 1. To reboot the gateway, run the following command:

```
reboot
```

Step 2. To safely turn the gateway off, run the following command:

```
shutdown 0
```

2.2.5 How to connect the gateway to the STEVAL-IDP004V2

To run the system correctly, connect the gateway to the STEVAL-IDP004V2 IO-Link master board.

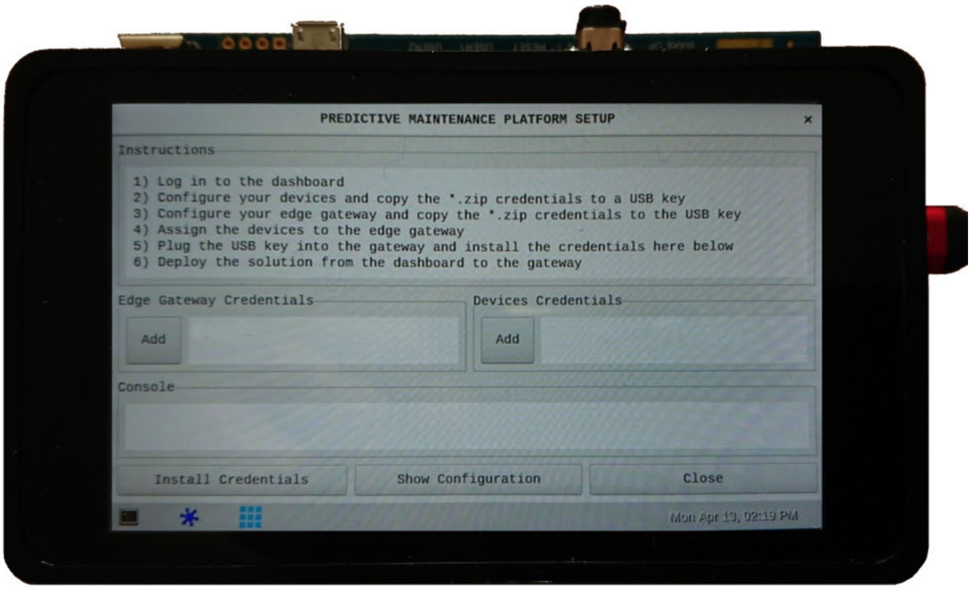
Connect a dongle USB to the RS485: on the board side to the DB9 connector (CN1) and on the gateway side to a USB port.

The DB9 connector is compatible with the EX-1303 dongle. If you use a different dongle, pay attention to the pinout compatibility (for further details, refer to the STEVAL-IDP004V2 schematic diagrams).

2.3 Application setup

From the Main GUI, click on the central button (“SETUP APPLICATION”) to start the configuration procedure to guide you through the steps to follow on the gateway and on the dashboard.

Figure 7. **GUI application setup**



PREDICTIVE MAINTENANCE PLATFORM SETUP

Instructions

1) Log in to the dashboard
2) Configure your devices and copy the *.zip credentials to a USB key
3) Configure your edge gateway and copy the *.zip credentials to the USB key
4) Assign the devices to the edge gateway
5) Plug the USB key into the gateway and install the credentials here below
6) Deploy the solution from the dashboard to the gateway

Step 1. Log in to the dashboard.

Step 2. Configure your devices and copy the *.zip credentials to a USB key.

Step 3. Configure your edge gateway and copy the *.zip credentials to the USB key.

Step 4. Assign the devices to the edge gateway.

Step 5. Plug the USB key into the gateway and install the credentials.

Step 6. Deploy the solution from the dashboard to the gateway.

2.3.1 Log in to the dashboard

Important: *You need a valid myST account to launch the dashboard and register devices.*

Step 1. Open the dashboard and log in with myST credentials:

– https://dsh-predmnt.st.com/

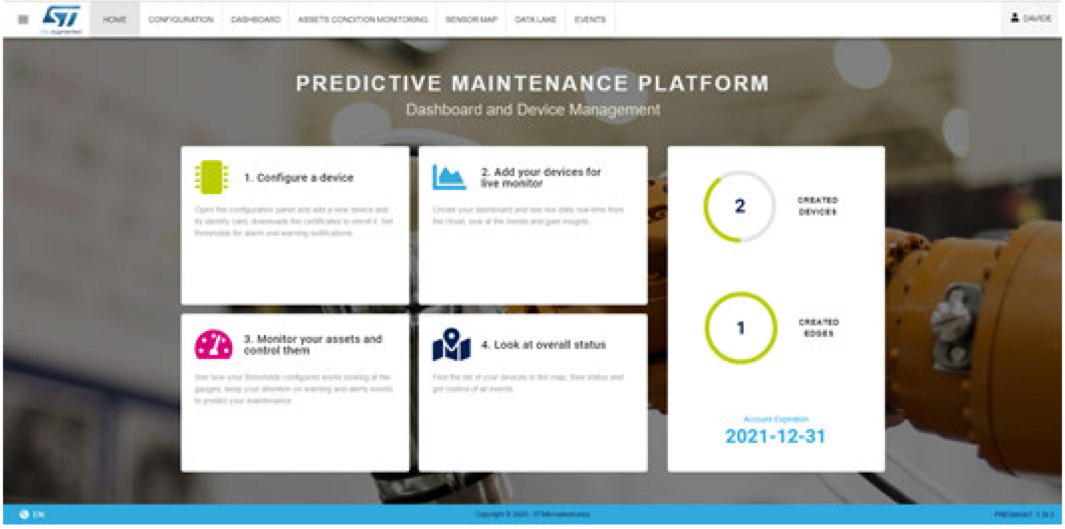
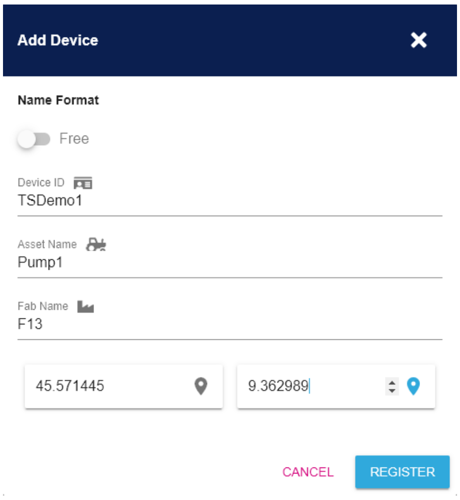

HOME
CONFIGURATION
DASHBOARD
ASSETS CONDITION MONITORING
SENSOR MAP
DATA LAKE
EVENTS
DAVIDE
PREDICTIVE MAINTENANCE PLATFORM
Dashboard and Device Management
1. Configure a device
2. Add your devices for live monitor
3. Monitor your assets and control them
4. Look at overall status
2
CREATED DEVICES
1
CREATED EDGES
Account Expiration
2021-12-31
EN

Figure 8. **Predictive Maintenance Platform main screen**

2.3.2 How to configure devices

Step 1. Click on [**Register a new device**] and then on [**DEVICES**] panel.

Step 2. Click [**Add Device**] and register two devices with an appropriate name and optional information.



Add Device

Name Format

Free

Device ID: TSDemo1

Asset Name: Pump1

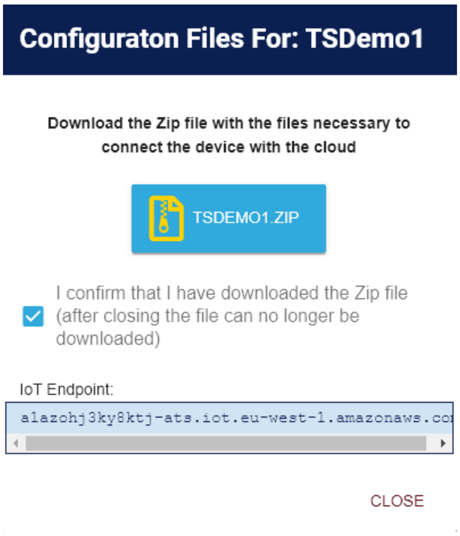
Fab Name: F13

45.571445

9.362989

Figure 9. **Add Device page**

Step 3. Download the corresponding zip file (containing certificate and key) before closing the popup window and copy it to the root of a USB key.



Configuraton Files For: TSDemo1

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

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

IoT Endpoint:

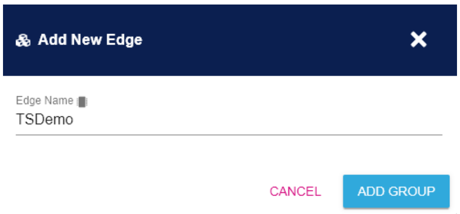
```
a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.co
```

Figure 10. Download configuration files

2.3.3 How to configure an edge gateway

Step 1. Go to the [**EDGE GATEWAYS**] dashboard panel.

Step 2. Click [**Add Device**] and register an edge gateway with an appropriate name.



Edge Name: TSDemo

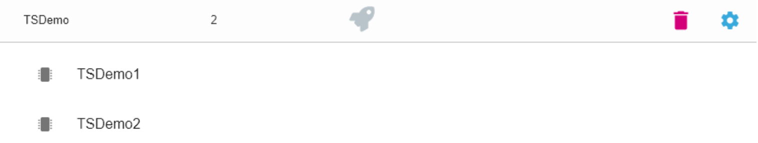
Figure 11. Add new edge

Step 3. Download the corresponding zip file (certificate and key credentials) before closing the popup window and copy it to the root of the USB key previously used.

2.3.4 How to assign devices to an edge gateway

Step 1. From the [**EDGE GATEWAYS**] dashboard panel, click the [**Setting**] gear icon and then [**Devices**].

Step 2. Select the devices you want to add to the gateway and click [**Save**].



TSDemo 2

TSDemo1

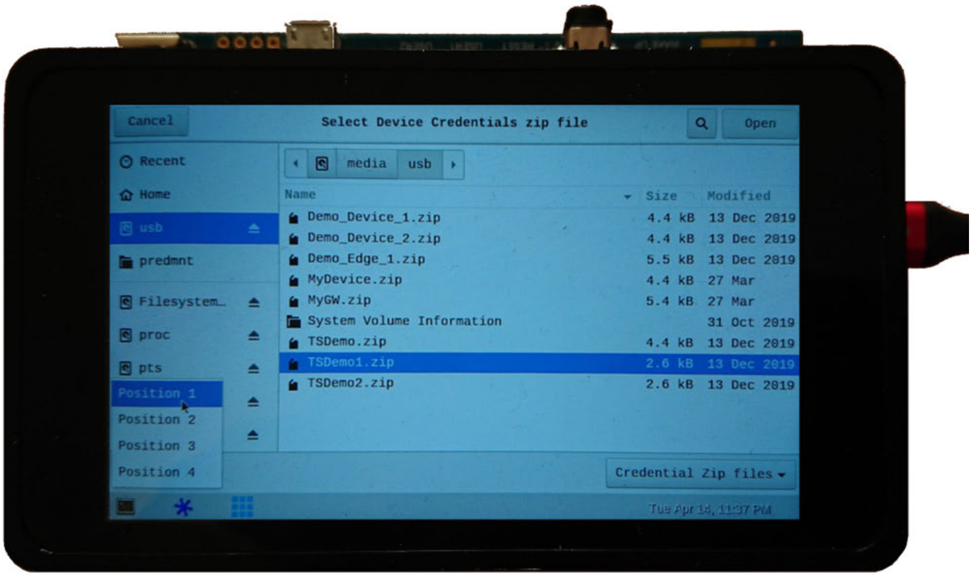
TSDemo2

Figure 12. Assign devices to an edge gateway

2.3.5 How to install credentials to the gateway

Step 1. Plug the previously used USB key to the gateway and add the gateway credentials and up to four devices by clicking on the corresponding [**Add**] buttons.

Step 2. Select the position of the devices according to the position they have on the masterboard (from 1 to 4).



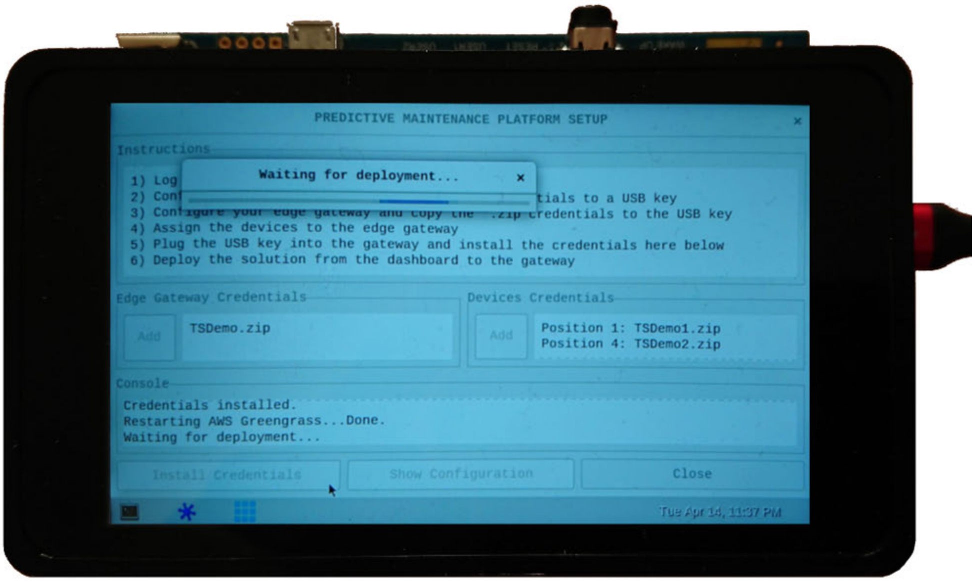
Select Device Credentials zip file

Name	Size	Modified
Demo_Device_1.zip	4.4 kB	13 Dec 2019
Demo_Device_2.zip	4.4 kB	13 Dec 2019
Demo_Edge_1.zip	5.5 kB	13 Dec 2019
MyDevice.zip	4.4 kB	27 Mar
MyGW.zip	5.4 kB	27 Mar
System Volume Information		31 Oct 2019
TSDemo.zip	4.4 kB	13 Dec 2019
TSDemo1.zip	2.6 kB	13 Dec 2019
TSDemo2.zip	2.6 kB	13 Dec 2019

Figure 13. **Assign devices to an edge gateway**

Step 3. Click the [**Install Credentials**] button to install the credentials on the gateway.

The Greengrass daemon is restarted and the gateway waits for deployment from the dashboard.



PREDICTIVE MAINTENANCE PLATFORM SETUP

Instructions

```
1) Log
2) Conf                                          tials to a USB key
3) Configure your edge gateway and copy the .zip credentials to the USB key
4) Assign the devices to the edge gateway
5) Plug the USB key into the gateway and install the credentials here below
6) Deploy the solution from the dashboard to the gateway
```

Waiting for deployment...

Edge Gateway Credentials: TSDemo.zip

Devices Credentials:

```
Position 1: TSDemo1.zip
Position 4: TSDemo2.zip
```

Console

```
Credentials installed.
Restarting AWS Greengrass...Done.
Waiting for deployment...
```

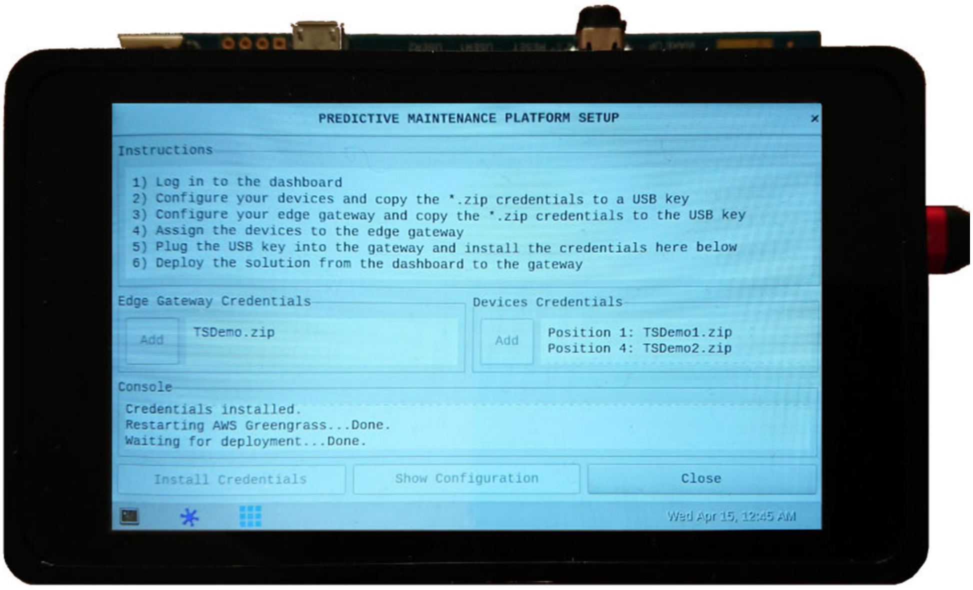
Figure 14. **Waiting for deployment**

2.3.6 How to deploy a solution

Step 1. Move to the [**EDGE GATEWAYS**] panel of the dashboard, click the [**Setting**] gear icon, select [**Deploy**] and then [**CONFIRM**].

If the connection is correctly working, after some seconds the deployment successfully completes and the gateway is configured.

Figure 15. **Deployment successful on the gateway**



PREDICTIVE MAINTENANCE PLATFORM SETUP

Instructions

```
1) Log in to the dashboard
2) Configure your devices and copy the *.zip credentials to a USB key
3) Configure your edge gateway and copy the *.zip credentials to the USB key
4) Assign the devices to the edge gateway
5) Plug the USB key into the gateway and install the credentials here below
6) Deploy the solution from the dashboard to the gateway
```

Edge Gateway Credentials: TSDemo.zip

Devices Credentials:

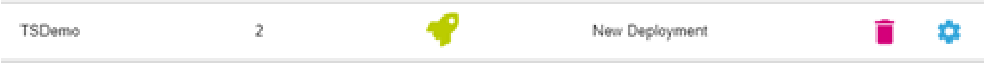
```
Position 1: TSDemo1.zip
Position 4: TSDemo2.zip
```

Console

```
Credentials installed.
Restarting AWS Greengrass...Done.
Waiting for deployment...Done.
```

Step 2. Reload the web page and check whether the status of the “New Deployment” operation has properly completed (green icon); repeat if necessary.

Figure 16. **Deployment successful on the dashboard**



TSDemo	2	New Deployment

2.4 Starting the application

2.4.1 How to activate the vibration setup

Step 1. Connect the vibration setup to the gateway via USB cable.

Step 2. Power the vibration setup on.

Step 3. Set the vibration setup speed to the desired value.

2.4.2 How to start the application

Step 1. Start the application:

- From the Main GUI, click on the [**RUN APPLICATION**] button to start the application: a new window pops up showing the output of the underlying application.
- Alternatively, from a terminal, run the following script

```
/usr/local/predmnt/start.sh
```

- or launch the following commands:
  - `/greengrass/ggc/core/greengrassd restart`
  - `export PYTHONPATH=$PYTHONPATH:/usr/local/predmnt/`
  - `python3 /usr/local/predmnt/pmp.py -c /usr/local/predmnt/pmp.json`

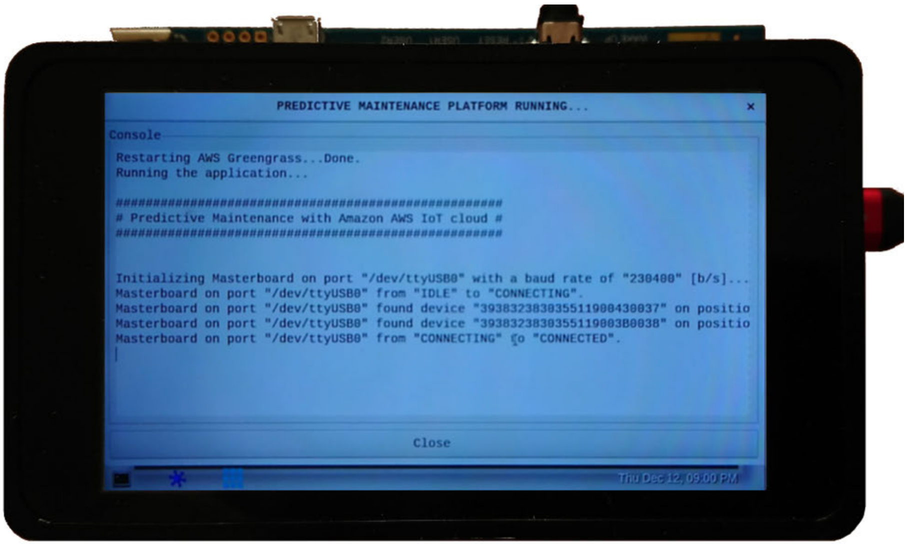
2.5 Condition Monitoring

2.5.1 Data visualization on the gateway

At application startup, on the gateway:

1. Greengrass daemon starts.
2. WireST-SDK initializes the masterboard and sensor devices.

Figure 17. **Greengrass startup and device initialization**



PREDICTIVE MAINTENANCE PLATFORM RUNNING...

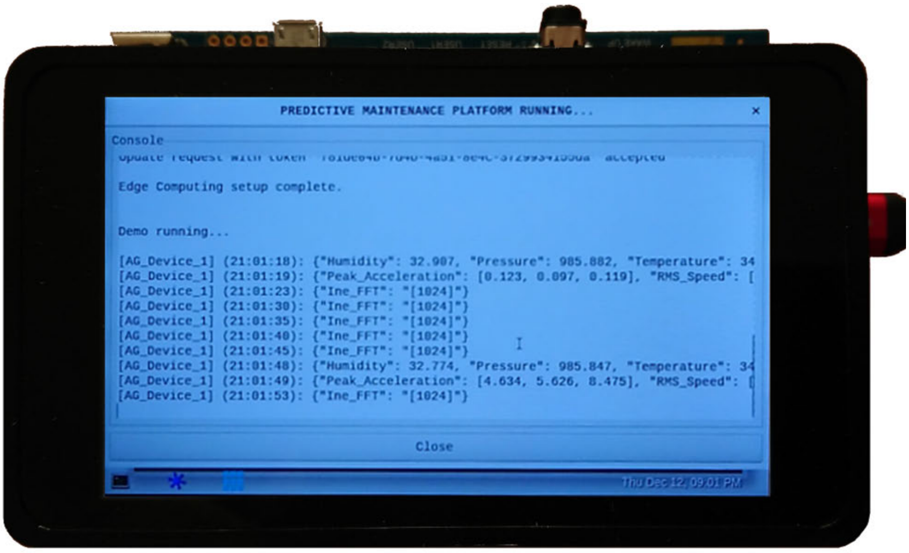
Console

```
Restarting AWS Greengrass...Done.
Running the application...

####################################################
# Predictive Maintenance with Amazon AWS IoT cloud #
####################################################


Initializing Masterboard on port "/dev/ttyUSB0" with a baud rate of "230400" [b/s]...
Masterboard on port "/dev/ttyUSB0" from "IDLE" to "CONNECTING".
Masterboard on port "/dev/ttyUSB0" found device "393832383035511900430037" on positio
Masterboard on port "/dev/ttyUSB0" found device "3938323830355119003B0038" on positio
Masterboard on port "/dev/ttyUSB0" from "CONNECTING" to "CONNECTED".
```

3. Greengrass daemon contacts Greengrass core on the cloud through EdgeST-SDK.
4. Devices and their counterparts on the cloud start communication.

5. The application receives data from the sensors and sends them to the cloud.

Figure 18. Gateway receives data from the sensors



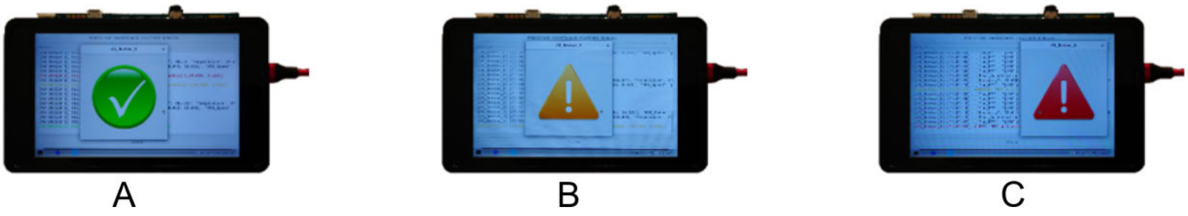
```
Update request with token "781de840-7040-4a51-8e4c-37299341550a" accepted

Edge Computing setup complete.


Demo running...

[AG_Device_1] (21:01:18): {"Humidity": 32.907, "Pressure": 985.882, "Temperature": 34
[AG_Device_1] (21:01:19): {"Peak_Acceleration": [0.123, 0.097, 0.119], "RMS_Speed": [
[AG_Device_1] (21:01:23): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:01:30): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:01:35): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:01:40): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:01:45): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:01:48): {"Humidity": 32.774, "Pressure": 985.847, "Temperature": 34
[AG_Device_1] (21:01:49): {"Peak_Acceleration": [4.634, 5.626, 8.475], "RMS_Speed": [
[AG_Device_1] (21:01:53): {"Ine_FFT": "[1024]"}
```

6. Optional: if the solution deployed from the dashboard contains a Lambda function (depending on the dashboard implementation) to process data locally (typically a filter on the Fast Fourier Transform (FFT) of the vibration data), the alarms triggered are shown on the gateway screen.

   Different alarm windows can pop up on the screen and an acoustic alarm is played through the audio jack on a connected speaker.

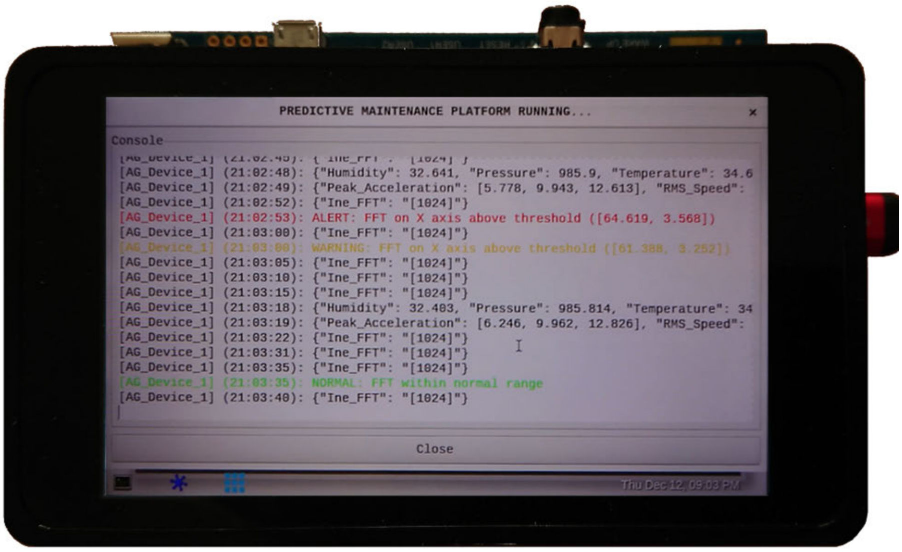
Figure 19. Alarm pop-up windows

A. Normal: in case the FFT data are within the normal range
B. Warning: in case FFT data overcome the FFT warning threshold
C. Critical: in case FFT data overcome the FFT critical threshold



Moreover, a colored log of data and alarms is shown.

Figure 20. Alarm logs



```
[AG_Device_1] (21:02:45): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:02:48): {"Humidity": 32.641, "Pressure": 985.9, "Temperature": 34.6
[AG_Device_1] (21:02:49): {"Peak_Acceleration": [5.778, 9.943, 12.613], "RMS_Speed":
[AG_Device_1] (21:02:52): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:02:53): ALERT: FFT on X axis above threshold ([64.619, 3.568])
[AG_Device_1] (21:03:00): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:00): WARNING: FFT on X axis above threshold ([61.388, 3.252])
[AG_Device_1] (21:03:05): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:10): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:15): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:18): {"Humidity": 32.403, "Pressure": 985.814, "Temperature": 34
[AG_Device_1] (21:03:19): {"Peak_Acceleration": [6.246, 9.962, 12.826], "RMS_Speed":
[AG_Device_1] (21:03:22): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:31): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:35): {"Ine_FFT": "[1024]"}
[AG_Device_1] (21:03:35): NORMAL: FFT within normal range
[AG_Device_1] (21:03:40): {"Ine_FFT": "[1024]"}
```

Alarm signals are also sent to the cloud dashboard for further use.

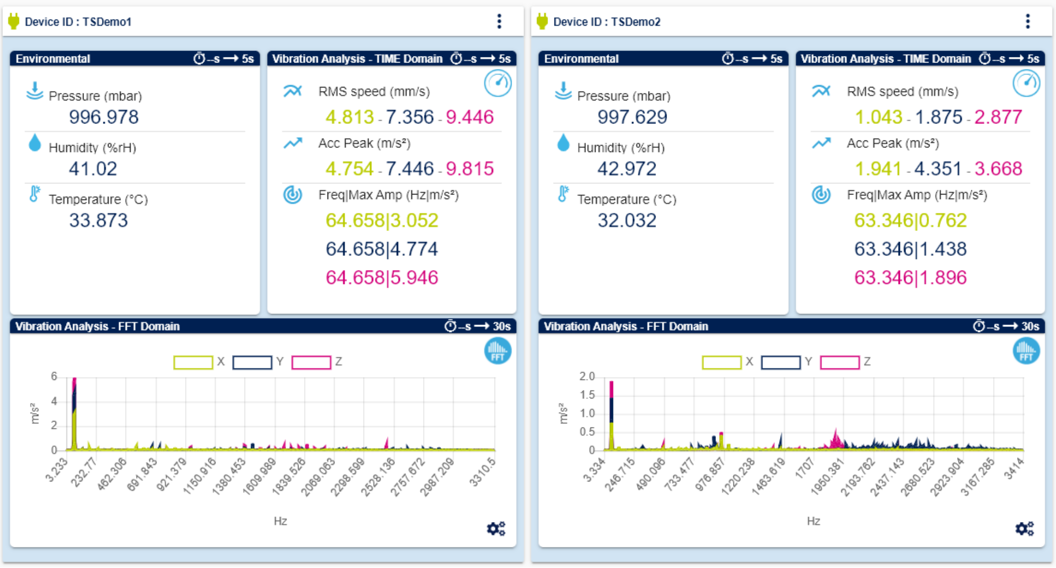
2.5.2 Data visualization on the dashboard

Follow the procedure below to view the sensor data on the dashboard.

Step 1. Open the dashboard and log in with myST credentials:
https://dsh-predmnt.st.com/

Step 2. Click on [**DASHBOARD**], then [**Add Device**] and select the desired devices to monitor.
A panel for each selected device opens and shows the exported data values.

Figure 21. **Device panel with sensor data and parameters**



Device ID : TSDemo1

Environmental –s → 5s

Pressure (mbar) 996.978

Humidity (%rH) 41.02

Temperature (°C) 33.873

Vibration Analysis - TIME Domain –s → 5s

RMS speed (mm/s) 4.813 - 7.356 - 9.446

Acc Peak (m/s²) 4.754 - 7.446 - 9.815

Freq|Max Amp (Hz|m/s²) 64.658|3.052 64.658|4.774 64.658|5.946

Vibration Analysis - FFT Domain –s → 30s

Device ID : TSDemo2

Environmental –s → 5s

Pressure (mbar) 997.629

Humidity (%rH) 42.972

Temperature (°C) 32.032

Vibration Analysis - TIME Domain –s → 5s

RMS speed (mm/s) 1.043 - 1.875 - 2.877

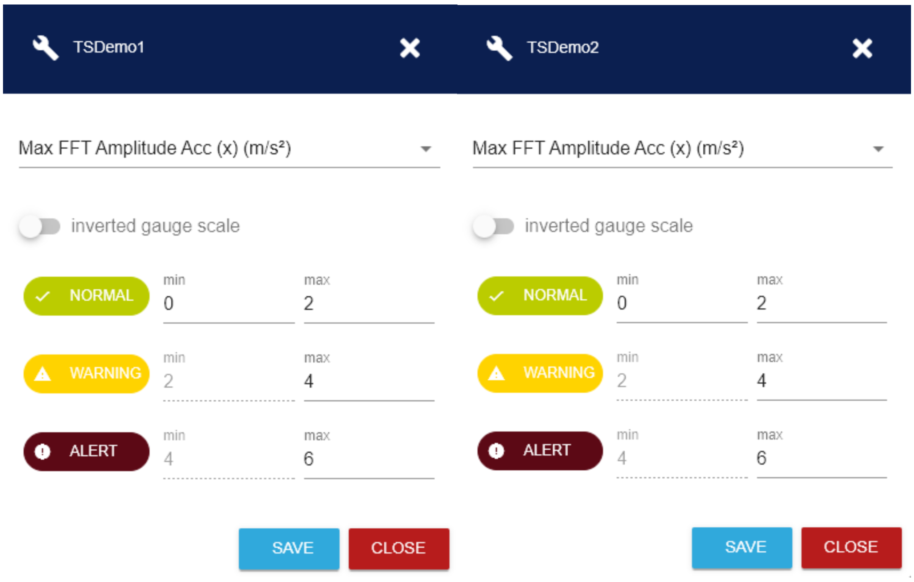
Acc Peak (m/s²) 1.941 - 4.351 - 3.668

Freq|Max Amp (Hz|m/s²) 63.346|0.762 63.346|1.438 63.346|1.896

Vibration Analysis - FFT Domain –s → 30s

Step 3. If needed, it is possible to configure some thresholds for the feature exported by the devices, which can be useful to quickly check the working condition of the devices through the gauge panel. From the main page, choose [**Register a new device**], select a device, click on the [**Settings**] gear icon, then on [**Configure Thresholds**] and choose a feature from the drop-down menu to configure the desired thresholds.

Figure 22. **Threshold settings for each device**



TSDemo1 ✕

Max FFT Amplitude Acc (x) (m/s²)

inverted gauge scale

	min	max
✓ NORMAL	0	2
WARNING	2	4
ALERT	4	6

SAVE CLOSE

TSDemo2 ✕

Max FFT Amplitude Acc (x) (m/s²)

inverted gauge scale

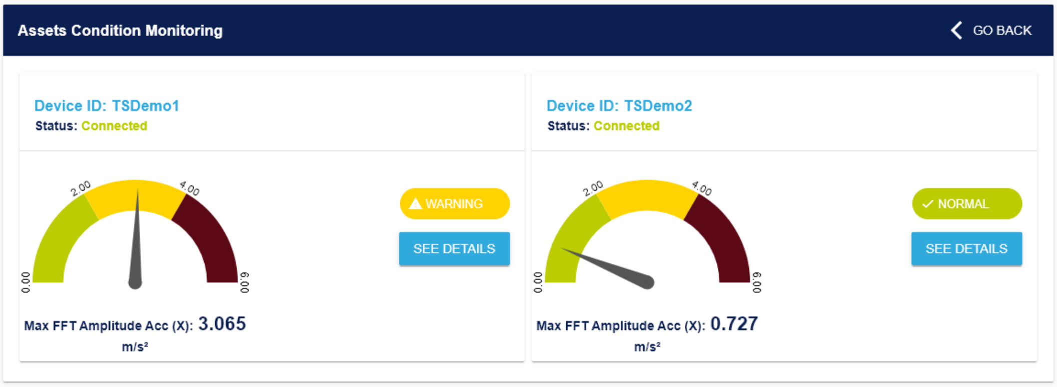
	min	max
✓ NORMAL	0	2
WARNING	2	4
ALERT	4	6

SAVE CLOSE

Step 4. Click on [**ASSETS CONDITION MONITORING**].

A gauge panel appears for each selected device showing its working condition according to the last configured feature.

Figure 23. **Gauge panel for each device**



2.6 Stopping the application

2.6.1 How to stop the application

Step 1. To stop the application:

- From the “RUN APPLICATION” GUI, click on the [**Close**] button
- Alternatively, press [**CTRL+C**] on the terminal where the application was launched
- Or, from a different terminal, run the stop script:

```
/usr/local/predmnt/stop.sh
```

2.6.2 How to deactivate the vibration setup

Step 1. Set the speed of the vibration setup to zero.

Step 2. Power vibration setup off.

3 Additional information on gateway application configuration

Additional information, such as edge gateway credentials, Greengrass configuration and configuration of the application on the gateway, could be useful when developing applications and for debugging issues.

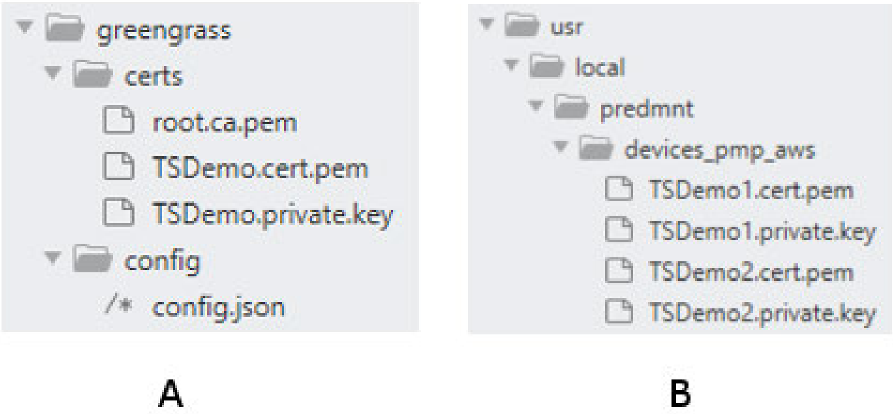
3.1 Credentials

The “/greengrass” folder contains the edge gateway credentials, the Root Certification Authority certificate file (root.ca.pem) and the Greengrass configuration file (config.json).

The “/usr/local/predmnt/devices_pmp_aws” folder contains the device credentials.

Figure 24. **Credentials on the gateway filesystem**

A. Edge gateway credentials
B. Device credentials



```
greengrass
    certs
        root.ca.pem
        TSDemo.cert.pem
        TSDemo.private.key
    config
        config.json
```

```
usr
    local
        predmnt
            devices_pmp_aws
                TSDemo1.cert.pem
                TSDemo1.private.key
                TSDemo2.cert.pem
                TSDemo2.private.key
```

3.2 Greengrass configuration

As soon as the Greengrass daemon starts, the “config.json” file allows it to get information about how to connect to the Greengrass core of the cloud application.

The code below is an example of configuration file.

```
{
  "coreThing" : {
    "caPath" : "root.ca.pem",
    "certPath" : "TSDemo.cert.pem",
    "keyPath" : "TSDemo.private.key",
    "thingArn" : "arn:aws:iot:eu-west-1:982787141379:thing/TSDemo_Core",
    "iotHost" : "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com",
    "ggHost" : "greengrass-ats.iot.eu-west-1.amazonaws.com",
    "keepAlive" : 600
  },
  "runtime" : {
    "cgroup" : {
      "useSystemd" : "yes"
    }
  },
  "managedRespawn" : false,
  "crypto" : {
    "principals" : {
      "SecretsManager" : {
        "privateKeyPath": "file:///greengrass/certs/TSDemo.private.key"
      },
      "IoTCertificate" : {
        "privateKeyPath": "file:///greengrass/certs/TSDemo.private.key",
        "certificatePath": "file:///greengrass/certs/TSDemo.cert.pem"
      }
    },
    "caPath" : "file:///greengrass/certs/root.ca.pem"
  }
}
```

3.3 Application configuration

The application user settings are stored in the “/usr/local/predmnt/pmp.json” configuration file.

```
{
    "serial_port": {
        "name": "/dev/ttyUSB0",
        "baudrate_bits_per_second": 230400
    },
    "setup": {
        "use_sensors": true,
        "use_cloud": true,
        "use_threads_for_polling_sensors": true,
        "device_certificates_path": "/usr/local/predmnt/devices_pmp_aws",
        "devices": [
            {
                "name": "TSDemo1",
                "position": 1
            },
            {
                "name": "TSDemo2",
                "position": 4
            }
        ]
    },
    "dump": {
        "env_samples": 0,
        "tdm_samples": 0,
        "fdm_samples": 0
    }
}
```

The code above shows an example of application configuration file on the gateway, containing the following parameters:

- `serial_port`: name and baud rate of the serial port used
- `use_sensors`: to use the sensor device real setup or to simulate random data
- `use_cloud`: to send data to the cloud or not
- `use_threads_for_polling_sensors`: to run a separate thread for each data domain (Environmental, Inertial_TDM, Inertial_FDM) for each sensor device or to poll them sequentially
- `devices`: to list the name and position of the configured devices on the masterboard
- `dump`: to dump the domain data (Environmental, Inertial_TDM, Inertial_FDM) up to the number of samples provided

Note: *You can change these parameters via command-line by editing the configuration file, if needed.*

4 Troubleshooting

4.1 Correct behavior

The code below shows an example of correct behavior when running the application.

```
Greengrass successfully started with PID: 1933

####################################################
# Predictive Maintenance with Amazon AWS IoT cloud #
####################################################


Initializing Masterboard on port "/dev/ttyUSB0" with a baud rate of "230400" [b/s]...
Masterboard on port "/dev/ttyUSB0" from "IDLE" to "CONNECTING".
Masterboard on port "/dev/ttyUSB0" found device "393832383035511900430037" on position "1".
Masterboard on port "/dev/ttyUSB0" found device "3938323830355119003B0038" on position "4".
Masterboard on port "/dev/ttyUSB0" from "CONNECTING" to "CONNECTED".

Initializing IO-Link Devices...
Device "TSDemo1" on position "1" initialized.
Device "TSDemo2" on position "4" initialized.

IO-Link setup complete.


Initializing Edge Computing...

AWS Greengrass service with endpoint "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com" from
"IDLE" to "DISCOVERING_CORE".
AWS Greengrass service with endpoint "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com" from
"DISCOVERING_CORE" to "CORE_DISCOVERED".
Client "TSDemo1" from "IDLE" to "CONNECTING".
Client "TSDemo1" from "CONNECTING" to "CONNECTED".
Client "TSDemo2" from "IDLE" to "CONNECTING".
Client "TSDemo2" from "CONNECTING" to "CONNECTED".

Sending handshake information...

[TSDemo1] (15:28:16.829431): {"state": {"reported": {"Device_Type": "STEVAL-IPD005V1",
"Features": ["Environmental", "Inertial_TDM", "Inertial_FDM"], "Firmware": "Firmware Ver.
1"}}}
Update request with token "aed4fb7e-1004-4130-a0d6-fada6bbfa295" accepted
[TSDemo2] (15:28:21.059531): {"state": {"reported": {"Device_Type": "STEVAL-IPD005V1",
"Features": ["Environmental", "Inertial_TDM", "Inertial_FDM"], "Firmware": "Firmware Ver.
1"}}}
Update request with token "91d11010-e2f6-4273-92dd-89684859e81f" accepted

Edge Computing setup complete.


Demo running...

[TSDemo1] (15:28:24.389429): {"Humidity": 39.976, "Pressure": 990.625, "Temperature": 37.086}
[TSDemo2] (15:28:26.329349): {"Humidity": 39.548, "Pressure": 991.476, "Temperature": 36.55}
[TSDemo1] (15:28:27.689421): {"Peak_Acceleration": [0.147, 0.108, 0.13], "RMS_Speed":
[0.023, 0.024, 0.043]}
[TSDemo2] (15:28:29.529874): {"Peak_Acceleration": [0.144, 0.119, 0.127], "RMS_Speed":
[0.023, 0.017, 0.021]}
[TSDemo1] (15:28:33.260450): {"Ine_FFT": "[1024]"}
[TSDemo2] (15:28:37.081863): {"Ine_FFT": "[1024]"}
[…]
```

4.2 Missing configuration files

In case the “pmp.json” application configuration file is not found, the following error message appears:

```
[…]
####################################################
# Predictive Maintenance with Amazon AWS IoT cloud #
####################################################

Configuration file "/usr/local/predmnt/pmp.json" not found.

Exiting...
```

If the “config.json” Greengrass’ configuration file is not found, the following error message appears:

```
[…]
####################################################
# Predictive Maintenance with Amazon AWS IoT cloud #
####################################################

Configuration file "/greengrass/config/config.json" not found.

Exiting...
```

Solution: check whether the location of the file(s) is correct, then, when no error message is shown, run the application again.

4.3 Missing sensor devices

In case one or more device specified within the “pmp.json” configuration file cannot be initialized, you may get the following error message:

```
[…]
Initializing Masterboard on port "/dev/ttyUSB0" with a baud rate of "230400" [b/s]...
Masterboard on port "/dev/ttyUSB0" from "IDLE" to "CONNECTING".
Masterboard on port "/dev/ttyUSB0" found device "393832383035511900430037" on position "1".
Masterboard on port "/dev/ttyUSB0" from "CONNECTING" to "CONNECTED".

Initializing IO-Link Devices...
Device "TSDemo1" on position "1" initialized.

IO-Link setup incomplete.

Exiting...
```

Solution:

- check the connection between the missing sensor devices and the masterboard
- check the application configuration file
- when no error message is shown, run the application again

4.4 Missing device credentials

In case the certificate of some of the configured devices is not found, the following error message appears:

```
[…]
Initializing Edge Computing...

Invalid device certificate path: "/user/local/predmnt/devices_pmp_aws/TSDemo1.cert.pem"

Exiting...
```

In case the private key is missing, the following message appears:

```
[…]
Initializing Edge Computing...

Invalid device private key path: "/user/local/predmnt/devices_pmp_aws/TSDemo1.private.key"

Exiting...
```

Solution: check the location and the filenames of the certificate and the private key of the configured devices, then, when no error message is shown, run the application again.

4.5 Dashboard issues

In case there are issues with the dashboard or the deployment is not correctly working, the following error message appears:

```
[…]
Initializing Edge Computing...

AWS Greengrass service with endpoint "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com" from
"IDLE" to "DISCOVERING_CORE".
Discovery of the core related to the client "TSDemo1", with certificate
"/usr/local/predmnt/devices_pmp_aws/TSDemo1.cert.pem" and key
"/usr/local/predmnt/devices_pmp_aws/TSDemo1.private.key", failed after 3 retries.

Exiting...
```

When deploying a solution, the Greengrass daemon has to be running, and the status of the last operation on the cloud has to be successful (either deployment or reset).

When deploying with the help of the “SETUP APPLICATION” GUI, Greengrass is automatically started.

Instead, in case you want to do it from the command line:

- run the following command:

  ```
  /greengrass/ggc/core/greengrassd restart
  ```

- deploy and run again; if the problem persists, contact the dashboard administrators.

4.6 Cloud connectivity issues

In case there are issues with cloud connectivity, the following error message appears:

```
[…]
Initializing Edge Computing...

AWS Greengrass service with endpoint "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com" from
"IDLE" to "DISCOVERING_CORE".
AWS Greengrass service with endpoint "a1azohj3ky8ktj-ats.iot.eu-west-1.amazonaws.com" from
"DISCOVERING_CORE" to "CORE_DISCOVERED".
Client "TSDemo2" from "IDLE" to "CONNECTING".
Client "TSDemo2" from "CONNECTING" to "UNREACHABLE".
Client "TSDemo2" cannot connect to core.
AWS setup incomplete.

Exiting...
```

Solution: check your connection to the Internet, then run the application again.

4.7 Misalignment issues

In case you are running a firmware not aligned to the WireST-SDK and the main PMP application, the following error message might appear:

```
[…]
Edge Computing setup complete.


Demo running...

Read 1 elements. Discarded.
[…]
```

Solution: update the firmware of the sensors and masterboard, the WireST-SDK and the main application to the latest release. Then, run the application again.

4.8 Unexpected crash of the application

In case the graphical application crashes unexpectedly, restart it via command-line:

```
/usr/local/predmnt/start.sh --gui
```

Revision history

Table 1. **Document revision history**

Date	Version	Changes
27-Nov-2019	1	Initial release.
26-Feb-2020	2	Minor text edits.
24-Sep-2020	3	Updated all content to reflect new GUI release.
25-Jan-2022	4	Updated Section 1 Edge processing application overview, Section 2.2 Gateway setup, Section 2.2.1 How to create an image for the STM32MP1 discovery kit, Section 2.2.2 How to configure the gateway, Section 2.2.4 How to reboot and turn the gateway off, Section 2.3 Application setup, Section 2.3.1 Log in to the dashboard, Section 2.4.2 How to start the application, Section 2.5.2 Data visualization on the dashboard, Section 2.6.1 How to stop the application, Section 4.2 Missing configuration files, Section 4.5 Dashboard issues, and Section 4.8 Unexpected crash of the application. Added Section 2.2.5 How to connect the gateway to the STEVAL-IDP004V2.

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