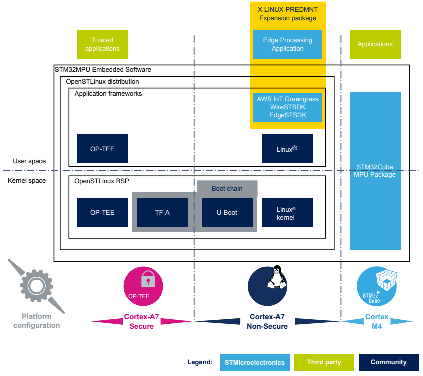
X-LINUX-PREDMNT

Data brief

STM32 MPU OpenSTLinux Expansion Pack for Predictive Maintenance applications



OpenSTLinux Distribution

Features

- Python™ 3.5.x (enabling Pillow module)
- Distributed as ready-to-use binary image (to be flashed on STM32MP1 microSD) and source code Yocto layer for OpenSTLinux.
- Sensor provisioning via AWS IoT Greengrass, enabling lambda functions to handle alarm generation on sensor data.
- Quick system setup through ST evaluation account in Amazon Web Services (limitations apply):
  - Trial basis duration: 6 months
  - Max number of devices: 5
  - Max number of Edge nodes: 1
- User data segregation.
- BSD (3-clause) license terms.

Description

The X-LINUX-PREDMNT application is an STM32 MPU OpenSTLinux Expansion Pack that runs on the Cortex A7 side of the MP1 microprocessor and used in conjunction with WIREST-SDK and EDGEST-SDK to implement Edge gateway functionality between wire-connected sensor nodes and cloud services. The overall predictive maintenance platform (PMP) setup involves registering sensor devices through a dashboard, configuring an STM32MP1 as an Edge gateway, and connecting with a cloud service provider.

Processed environmental and inertial data are sent to the IoT cloud, visualized on the dashboard, and used to detect conditions which may indicate the need for maintenance intervention. This particular solution includes the AWS IoT Greengrass Edge Computing service to allow local processing of sensor data through Lambda functions on the Edge gateway even in absence of cloud connectivity. Data synchronization when the cloud becomes reachable again is handled automatically.

Product summary	
STM32 MPU OpenSTLinux expansion pack for Predictive Maintenance	X-LINUX-PREDMNT
Cloud-based CdM and PdM web app	DSH-PREDMNT
Wire software development kit	WIREST-SDK
Firmware runs on: Edge computing SDK	EDGEST-SDK
Discovery kit with STM32MP157C MPU, Secure Boot and cryptography, LCD, Wi-Fi, and BLE	STM32MP157C-DK2
IO-Link master multi-port evaluation board based on L6360	STEVAL-IDP004V1
Applications	Condition Monitoring / Predictive Maintenance

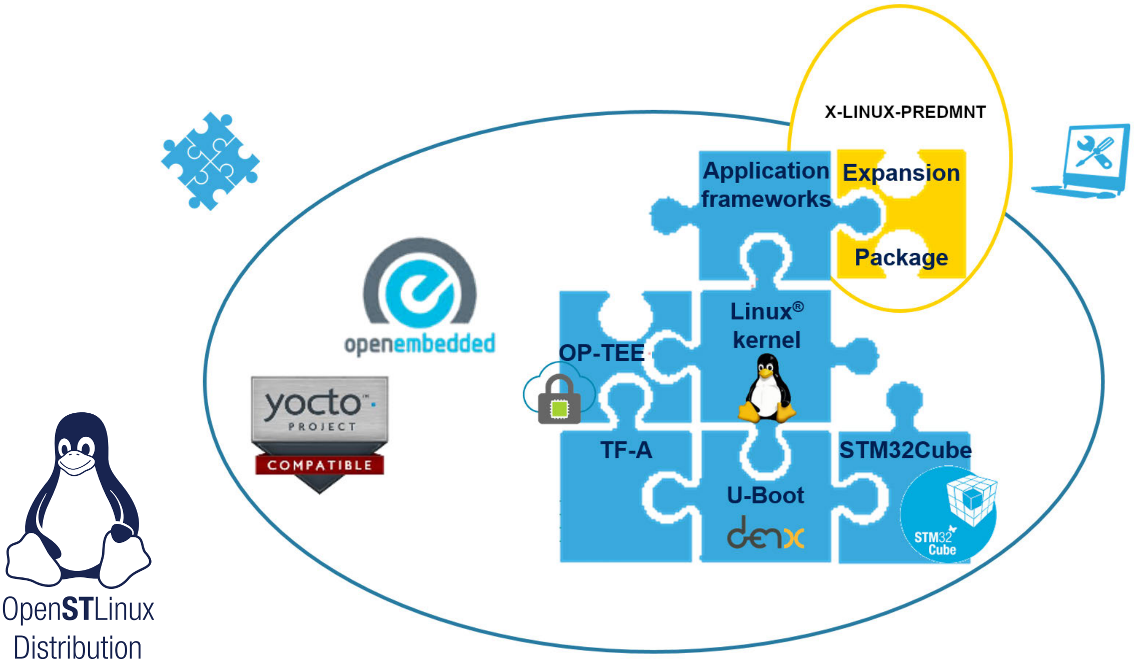
1 Overview of the X-LINUX-PREDMNT Expansion Package and Predictive Maintenance applications

1.1 General information

The X-LINUX-PREDMNT Expansion Package runs on STM32 microprocessors based on Arm® Cortex® cores.

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Figure 1. OpenSTLinux Distribution and Expansion Package



1.2 Predictive Maintenance scenarios

The traditional approach to the management of wear and tear in moving parts, especially in critical machinery, is to schedule periodic servicing or replacements based on machine or component manufacturer recommendations, or historical data, or both. As condition estimates are derived from typical or sample data, the timing of maintenance operations is at best approximate.

Predictive maintenance instead works with real data from sensors mounted near a specific component to monitor telltale condition indicators like temperature and vibration. This condition monitoring data can then be fed into dynamic predictive models for certain failure modes in order to derive tailored maintenance plans for single components or machines.

Comprehensive predictive maintenance solutions draw on many of the advanced technologies driving industry 4.0, including machine learning, ultra-low power microcontrollers, sophisticated battery power management, wired and wireless communication speed and network security, decentralized node processing and storage, edge gateways, and AI capable cloud services.

1.3 X-LINUX-PREDMNT for Edge processing with AWS IoT Greengrass

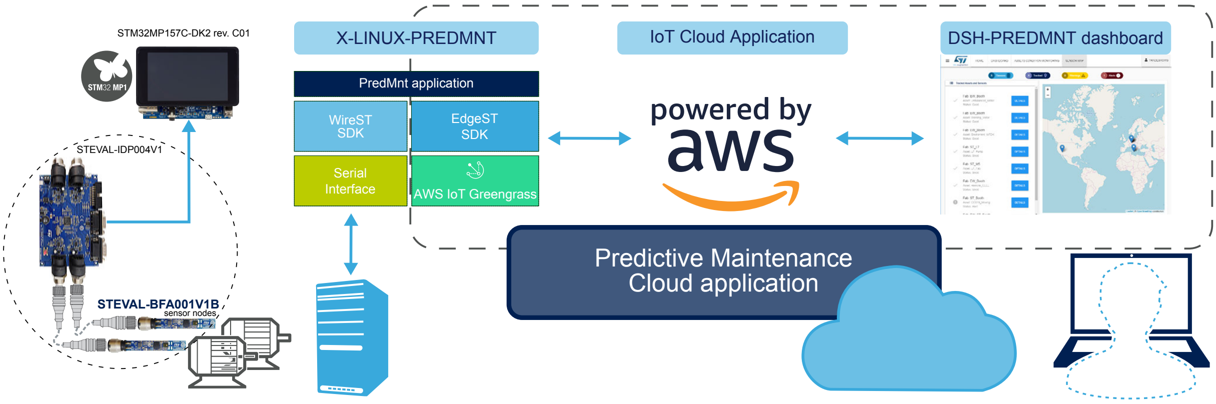
Smart sensor Edge nodes sample, preprocess and elaborate sensor data, and connect with higher level analysis and control centers, such as on premise data lakes and cloud applications.

The particular architecture determines the appropriate fieldbus or wireless connectivity solution for each scenario. IO Link, for example, is an emerging fieldbus protocol designed for sensor data retrieval and transmission to PLC or controller.

STEVAL-BFA001V1B is a smart sensor node that can be used together with STEVAL-IDP004V1 by emulating IO Link capability through serial interfaces. The kits can monitor up to 4 nodes, and data can be collected and to some extent processed in an Edge gateway consisting of an STM32MP157C-DK2 kit running X-LINUX-PREDMNT software, which includes the AWS IoT Greengrass service. The DSH-PREDMNT dashboard can be used to handle the cloud application for device provisioning, configuration through the Shadow service, and data injection and analysis.

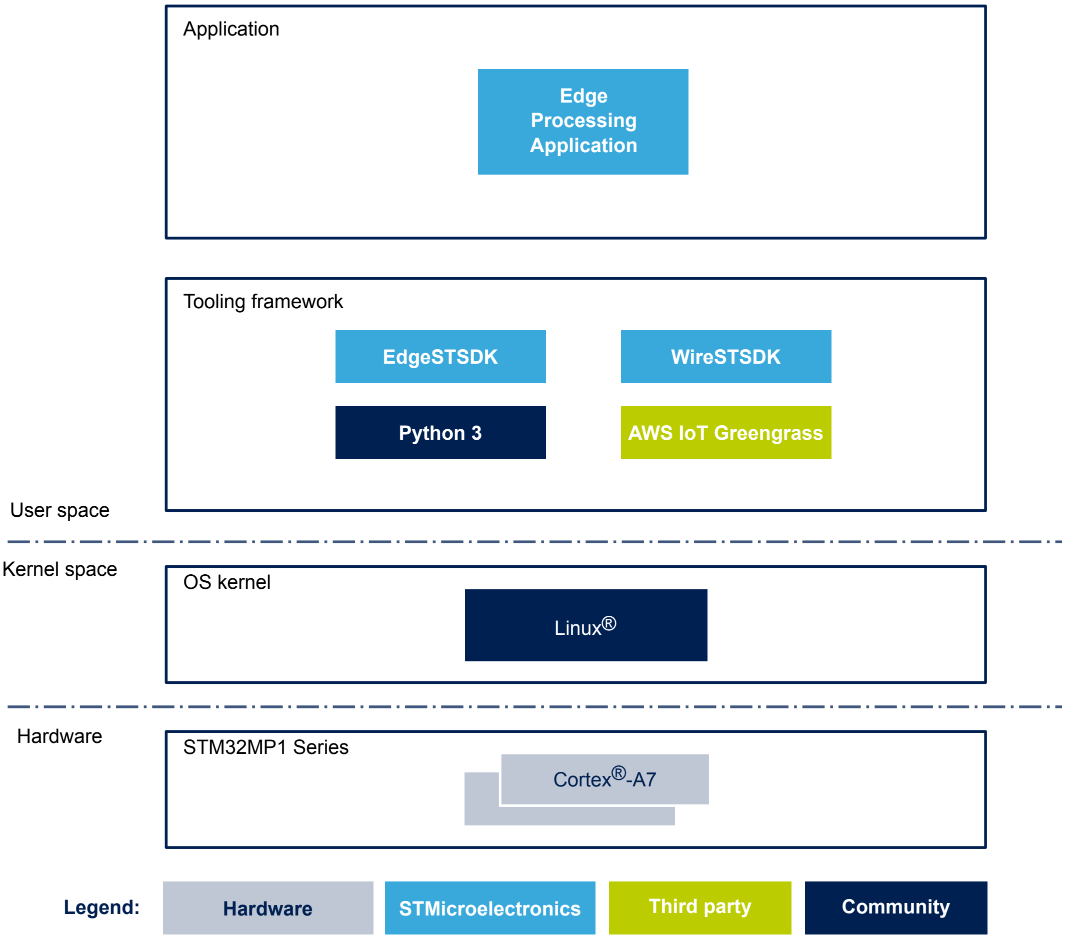
Figure 2. **Condition monitoring and Edge to Cloud: from sensors to gateway to cloud dashboard**

The Edge node collects environmental data and FFT data from accelerometers processed by the STEVAL-BFA001V1B kit, which is then sent via MQTT over Ethernet or Wi-Fi to the DSH-PREDMNT dashboard based on the AWS infrastructure.



1.4 X-LINUX-PREDMNT software architecture

Figure 3. Top-level architecture of the X-LINUX-PREDMNT Expansion Package



The X-LINUX-PREDMNT software includes an application layer that relies on the following SDKs to handle interaction with the IoT Cloud application and with the communication interface for the STEVAL-IDP004V1.

Amazon AWS IoT Python SDK

- https://github.com/aws/aws-iot-device-sdk-python
  The AWS IoT Device SDK for Python allows developers to write Python scripts to use their devices to access the AWS IoT platform through MQTT or MQTT over the WebSocket protocol. By connecting their devices to AWS IoT, users can securely work with the message broker, rules, and the device shadow (or thing shadow) provided by AWS IoT, and with other AWS services like AWS Lambda, Amazon Kinesis, Amazon S3, and more.

EdgeSTSDK

- https://github.com/STMicroelectronics/EdgeSTSDK_Python
  The proprietary EdgeST-SDK is an IoT edge computing abstraction library for Linux gateways. It relies on cloud platform edge SDKs to enable local execution of functions on a Linux gateway and synchronization with the cloud. More specifically, it enables the creation of virtual devices on the gateway to map non-IP connected devices (for example, via BLE), and the corresponding shadow devices on the cloud.

  Local computation can be directly performed on the gateway with the same logic written for the cloud, even when the Internet connection is lost: the shadow devices are synchronized with the virtual devices as soon as the Internet connection is available again.

- https://aws.amazon.com/greengrass/

  EdgeST-SDK supports the AWS IoT Greengrass Edge Computing Service, allowing the extension of AWS capability at device level. With AWS IoT Greengrass, connected devices can run AWS Lambda functions, execute predictions based on machine learning models, keep device data in sync, and communicate with other devices securely, even when not connected to the Internet. It is released under BSD (3-clause) license terms.

WireST-SDK

- https://github.com/STMicroelectronics/WireSTSDK_Python

  WireST-SDK is a computing abstraction library for Linux gateways that allows interfacing the gateway to wire-connected sensors. It supports IO-Link connected devices and implements a proprietary serial communication protocol on RS485 bus. The WireST-SDK is released under BSD (3-clause) license terms.

Other Python packages (pyserial, futures, enum34)

2 License information

X-LINUX-PREDMNT is delivered under the *Mix Ultimate Liberty+OSS+3rd-party V1* software license agreement (SLA0048).

Software component license agreements

The software components provided in this package come with different license schemes. Refer to wiki.st.com/stm32mpu/index.php/OpenSTLinux_licenses for details.

Additionally, Table 1 lists the component license agreements that are not provided through the link above.

Table 1. Complementary component licenses

Software component	Owner	License
AWS IoT Greengrass	AWS	Greengrass Core Software License Agreement
AWS IoT Python SDK	AWS	Apache Open Source license
Python packages (pyserial, futures, enum34)	Python Org	Python Software Foundation License (PSFL)

Revision history

Table 2. **Document revision history**

Date	Version	Changes
20-Nov-2019	1	Initial release.
29-Nov-2019	2	Updated cover page image
04-Feb-2020	3	Minor text edits Updated web link for EdgeSTSDK

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