

## Artificial intelligence (AI) Expansion Package for STM32 MPU OpenSTLinux



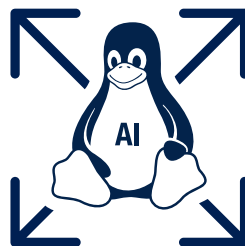
Image classification



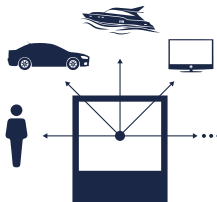
Object detection



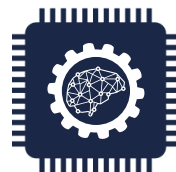
Pose estimation



### X-LINUX-AI



Semantic segmentation



Computer vision  
on-device learning



Face recognition

DT65761V4

Product status link

[X-LINUX-AI](#)



OpenSTLinux   
Expansion packages

## Features

### Software environment

- The X-LINUX-AI OpenSTLinux Expansion Package v6.1.0 is compatible with the Yocto Project® build system Scarthgap. It is validated over the OpenSTLinux Distribution v6.1

### AI frameworks

- STAI\_MPU unified API based on OpenVX™ (STM32MP23xx and STM32MP25xx only), TensorFlow™ Lite, and ONNX Runtime compatible with all STM32 MPU series
- TIM-VX™ 1.2.22 (STM32MP23xx and STM32MP25xx only)
- ONNX Runtime 1.19.2 with XNNPACK execution engine activated for CPU execution and VSINPU execution provider to address STM32MP2 NPU
- TensorFlow™ Lite 2.18.0 with VX-delegate (NPU/GPU for STM32MP25xx and STM32MP23xx only) and XNNPACK delegate activated (CPU only)
- ONNX 1.16.2 Python™ version for on-device learning
- PyTorch™ 2.3.1 Python™ version for on-device learning

### Applications

- Image classification
  - C++ / Python™ example using STAI\_MPU unified API based on the MobileNet v1 and v2 quantized models
- Object detection
  - C++ / Python™ example using STAI\_MPU unified API based on the SSD MobileNet v1 and v2 quantized models
- Face recognition
  - C++ example using STAI\_MPU unified API based on the BlazeFace and FaceNet quantized models (STM32MP23xx and STM32MP25xx only)
- Human pose estimation (STM32MP23xx and STM32MP25xx only)
  - Python™ example using STAI\_MPU unified API based on YOLOv8n pose quantized model
- Semantic segmentation (STM32MP23xx and STM32MP25xx only)
  - Python™ example using STAI\_MPU unified API based on DeepLabv3 quantized model
- People tracking and heatmap (STM32MP23xx and STM32MP25xx only)
  - Python™ example using STAI\_MPU unified API based on the YOLOv8n quantized models
- On-device learning for object detection (STM32MP23xx and STM32MP25xx only)
  - Python™ example using STAI\_MPU unified API based on SSD MobileNet v2 as the student and RT-DETR model as the teacher
  - Step-by-step JupyterLab notebook available for this application
- Application examples based on Gstreamer 1.22.x, GTK® 3.x, OpenCV 4.9.x, Pillow, Python™ 3

### On-target utilities

- X-LINUX-AI tool suite: software information, management of AI packages, and benchmarking of neural network models
- Support for a wide range of image sensors and camera modules for STM32 MPUs including
  - IMX335 (5MP) for STM32MP2 with the use of its internal ISP
  - GC2145
  - OV5640 for STM32MP13xx

### Host tools

- X-LINUX-AI SDK add-on extending the OpenSTLinux SDK with AI functionality to develop and build an AI application easily. The X-LINUX-AI SDK add-on supports all the above frameworks. It is available from the X-LINUX-AI product page
- Optimization and deployment of AI with the offline compiler available through the ST Edge AI Core (STEdgeAI-Core)

## Description

X-LINUX-AI is an STM32 MPU OpenSTLinux Expansion Package that targets artificial intelligence for STM32MP1 and STM32MP2 series microprocessors. It contains Linux® AI frameworks, as well as application examples to get started with some basic use cases.

The examples provided in X-LINUX-AI include a selection of optimized models for image classification, object detection, semantic segmentation, human pose estimation, and face recognition.

These examples rely on the STAI\_MPU API based on either the TensorFlow™ Lite inference engine, ONNX Runtime, or OpenVX™. They all support Python™ scripting and C/C++ applications.

## 1 General information

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The X-LINUX-AI Expansion Package runs on STM32 microprocessors based on Arm® Cortex® processors.

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



### 1.1 Ordering information

X-LINUX-AI is available for free download from the [www.st.com](http://www.st.com) website.

### 1.2 Versioning

Since its release v5.0.0, the major versioning of the X-LINUX-AI OpenSTLinux Expansion Package is aligned on the major versioning of the OpenSTLinux Distribution. This prevents painful backward compatibility attempts and makes dependencies straightforward.

The generic versioning X-LINUX-AI vx.y.z is built as follows:

- **x**: major version matching the OpenSTLinux Distribution major version. Each new major version is incompatible with previous OpenSTLinux Distribution versions.
- **y**: minor version, which is changed when new functionalities are added to the X-LINUX-AI OpenSTLinux Expansion Package in a backward compatible manner.
- **z**: patch version to introduce bug fixes. A patch version is implemented in a backward compatible manner.

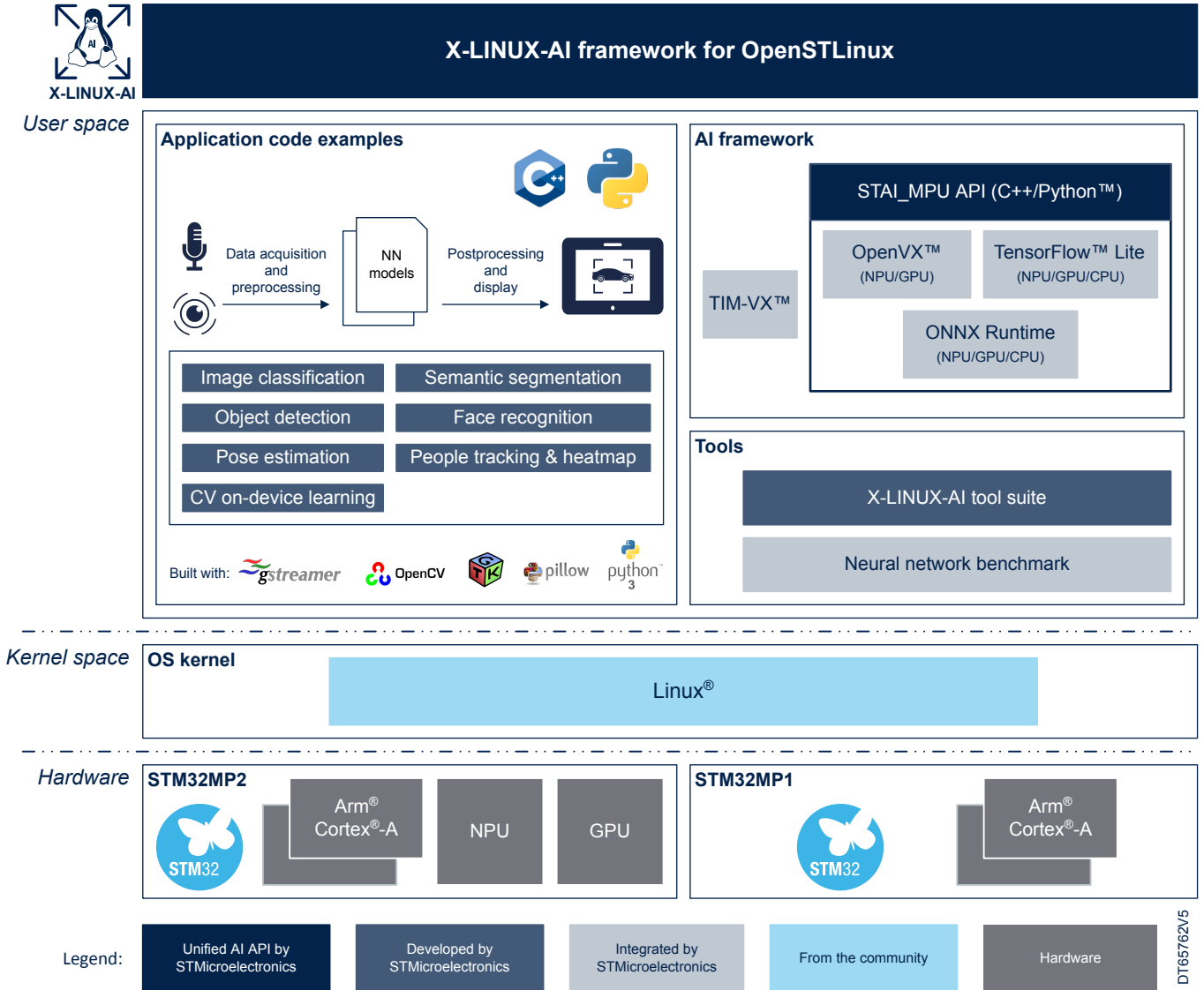
### 1.3 License

X-LINUX-AI is delivered under the [SLA0048](#) software license agreement and its Additional License Terms.

## 2 Software architecture

The top-level architecture of the X-LINUX-AI OpenSTLinux Expansion Package is shown in Figure 1.

Figure 1. X-LINUX-AI architecture



## Revision history

**Table 1. Document revision history**

Date	Revision	Changes
01-Jul-2020	1	Initial release.
08-Feb-2021	2	Added the prebuilt face recognition application, and updated NN tools and OpenSTLinux versions in <i>Features</i> and <i>Description</i> . Updated <i>Ordering information</i> .
02-Jul-2021	3	Added display configuration support and updated component versions in <i>Features</i> for X-LINUX-AI v2.1.1.
29-Jun-2022	4	Updated for X-LINUX-AI v2.2.0 with the X-LINUX-AI SDK add-on delivery, the focus on STMicroelectronics boards, and the discontinued supports for the Arm NN inference engine and Avenger96 board: <ul style="list-style-type: none"> <li>Updated <i>Features</i> and <i>Description</i></li> <li>Updated <i>X-LINUX-AI architecture</i></li> </ul>
21-Dec-2022	5	Updated for X-LINUX-AI v3.0.0 with the support for ONNX Runtime, and for the demonstration boards: <ul style="list-style-type: none"> <li>Updated <i>Features</i> and <i>Description</i></li> <li>Updated the cover picture and <i>X-LINUX-AI architecture</i></li> </ul>
07-Jul-2023	6	Updated for X-LINUX-AI v5.0.0 with XNNPACK support, performance improvement, new object detection applications, and new demonstration board: <ul style="list-style-type: none"> <li>Updated <i>Features</i> and <i>Description</i></li> <li>Updated <i>X-LINUX-AI architecture</i></li> <li>Added <i>Versioning</i></li> </ul>
02-Jul-2024	7	Updated for X-LINUX-AI v5.1.0 with the support for STM32MP2 series microprocessors, additional application examples, and the STAI_MPU unified API: <ul style="list-style-type: none"> <li>Updated the cover image</li> <li>Updated <i>Features</i> and <i>Description</i></li> <li>Updated <i>X-LINUX-AI architecture</i></li> </ul>
06-Dec-2024	8	Updated for X-LINUX-AI v6.0.0 with the support for STM32MP2 NPU, no delivery restriction on the face recognition application, and no Coral Edge TPU™ support: <ul style="list-style-type: none"> <li>Updated the cover image</li> <li>Updated <i>Features</i>, <i>Description</i>, and <i>Ordering information</i></li> <li>Updated <i>X-LINUX-AI architecture</i></li> </ul>
10-Jul-2025	9	Updated for X-LINUX-AI v6.1.0 with the support for computer vision on-device learning, and people tracking and heatmap: <ul style="list-style-type: none"> <li>Updated the cover image</li> <li>Updated <a href="#">Features</a></li> <li>Updated <a href="#">X-LINUX-AI architecture</a></li> </ul>

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