STMicroelectronics & Avnet IoTConnect

STM32MP2 Edge AI

November 2024

STM32MP2 microprocessor series

Robustness for complex industrial applications

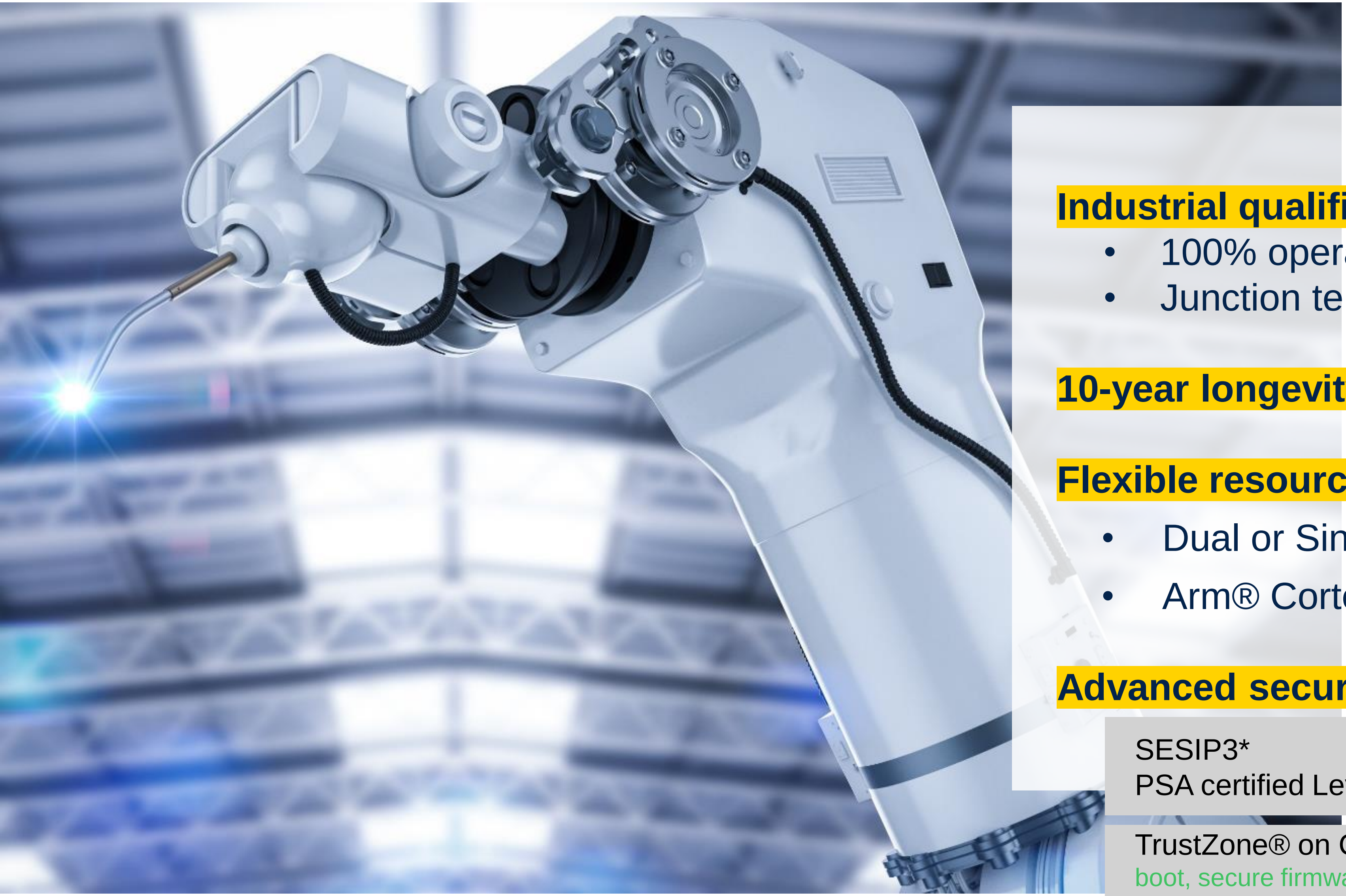
Rich interfaces supporting the growth of connected applications

64-bit MPU with advanced compute capabilities

Strong security

life.augmented

Robustness for complex industrial applications



STM32MP25x

Industrial qualification combining both:

- 100% operation time for 10 years
- Junction temperature: - 40°C to 125°C

10-year longevity commitment renewed every year

Flexible resource allocation between cores

- Dual or Single Arm® Cortex®-A35 up to 1.5 GHz
- Arm® Cortex®-M33 up to 400 MHz

Advanced security for Industry 4.0

SESIP3*
PSA certified Level 1*

TrustZone® on Cortex®-A & Cortex®-M: secure boot, secure firmware updates and cryptographic operations

LONGEVITY 10 YEARS COMMITMENT

Designed for highly connected applications

Industrial & factory automation

- Gateways
- PLCs
- HMIs
- Metering
- Bar code reader

- Anomaly detection
- Pose estimation
- People / object detection
- Face recognition
- Character recognition

Smart homes

- Gateways
- HMIs
- Whitegoods
- Door bell

- People / object detection
- Face recognition
- Voice recognition

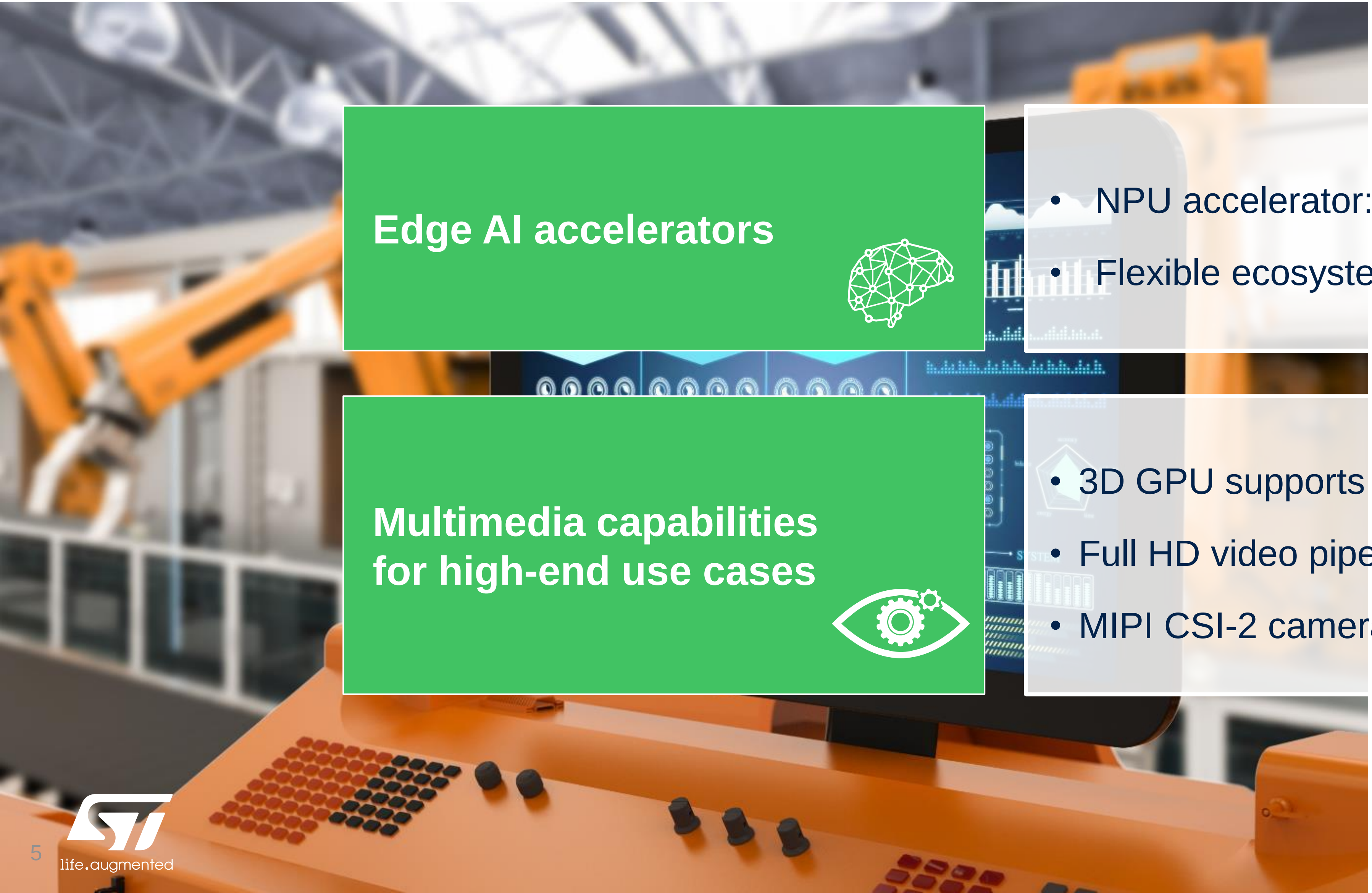
Smart city and infrastructure

- Power grid
- EV charging
- Metering
- HMIs

- Traffic management
- Energy management
- Vehicle / pedestrian recognition & tracking
- People & object detection

- **Secure boot**
- **Firmware & data encryption**
- **Context isolation**

64-bit MPU with advanced Edge AI capabilities



Edge AI accelerators

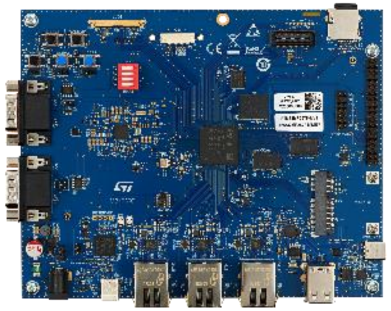
- NPU accelerator: **up to 1.35 TOPS**
- Flexible ecosystem to run AI on CPU, GPU, or NPU

Multimedia capabilities for high-end use cases

- 3D GPU supports up to 1080p resolution
- Full HD video pipe with RGB, LVDS & DSI outputs
- MIPI CSI-2 camera interface with ISP

Development tools for the STM32MP2 series

Speed-up evaluation, prototyping, and design



Evaluation board
STM32MP257F-EV1
($250)

LCD Display
B-LVDS7-WSVGA
($200)

Camera module
B-CAMS-IMX
($90)

DSI to HDMI
B-LCDAD-HDMI1
($29)

Available

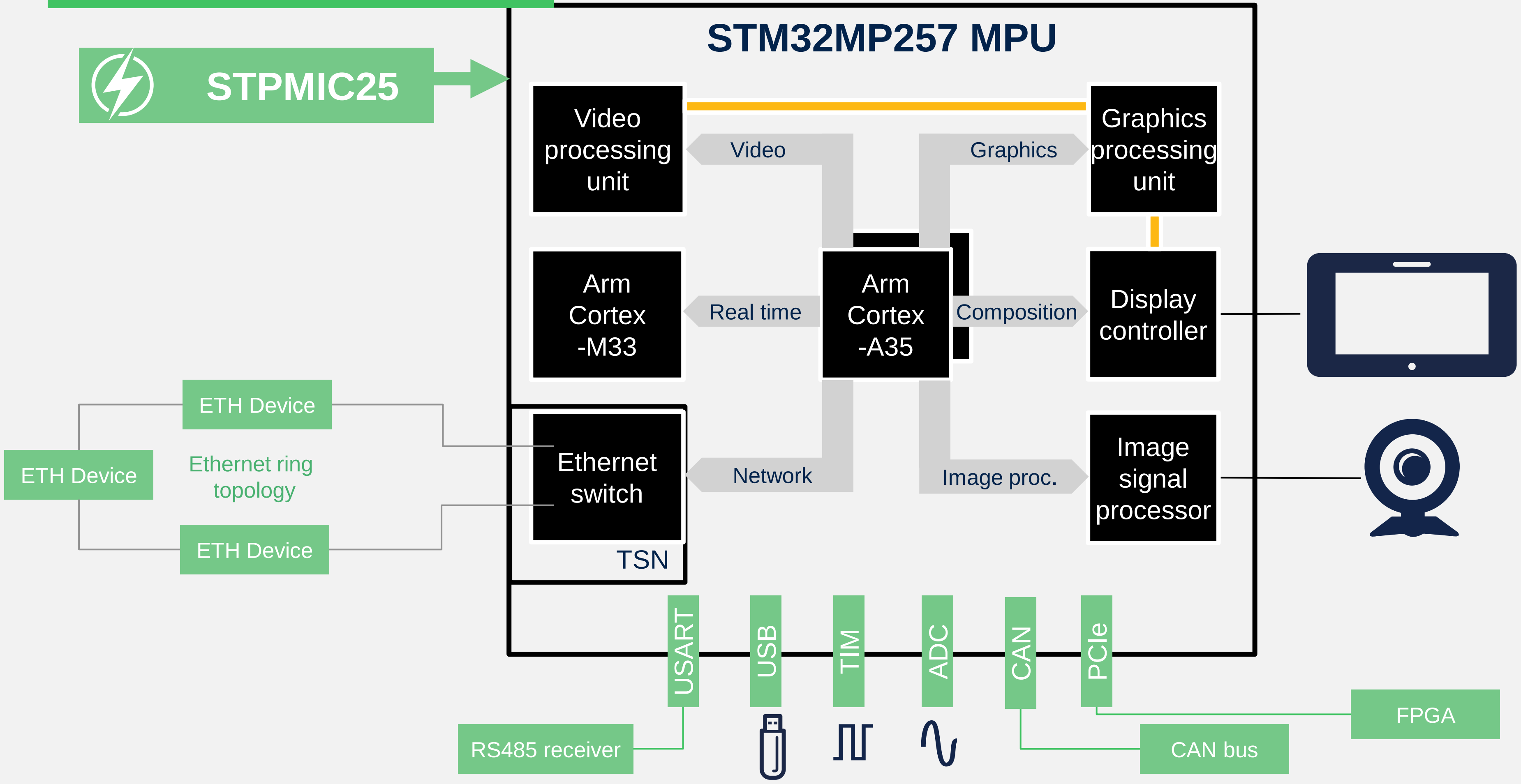
Discovery kit
STM32MP257-DK
(~$100)

December

More STM32-based dev tools available with our partners

Rich interfaces offload the CPU for connected applications

Industrial HMI gateway



STPMIC25

STM32MP257 MPU

Video processing unit

Graphics processing unit

Video

Graphics

Arm Cortex -M33

Real time

Arm Cortex -A35

Composition

Display controller

Ethernet switch

TSN

Network

Image proc.

Image signal processor

ETH Device

ETH Device

ETH Device

Ethernet ring topology

USART

USB

TIM

ADC

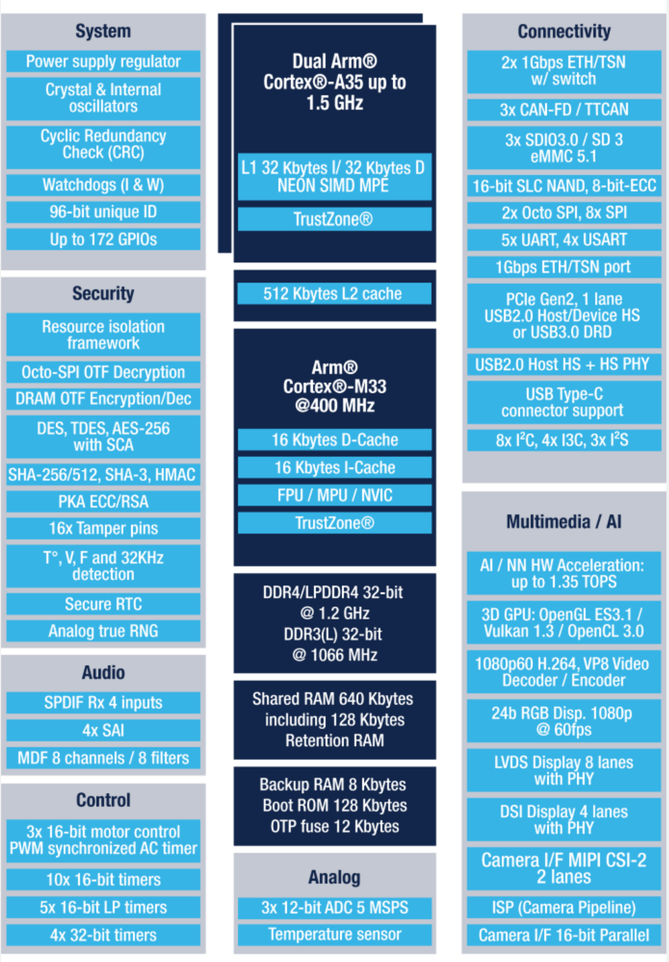
CAN

PCIe

RS485 receiver

CAN bus

FPGA



System

Power supply regulator

Crystal & Internal oscillators

Cyclic Redundancy Check (CRC)

Watchdogs (I & W)

96-bit unique ID

Up to 172 GPIOs

Security

Resource isolation framework

Octo-SPI OTF Decryption

DRAM OTF Encryption/Dec

DES, TDES, AES-256 with SCA

SHA-256/512, SHA-3, HMAC

PKA ECC/RSA

16x Tamper pins

T°, V, F and 32KHz detection

Secure RTC

Analog true RNG

Audio

SPDIF Rx 4 inputs

4x SAI

MDF 8 channels / 8 filters

Control

3x 16-bit motor control PWM synchronized AC timer

10x 16-bit timers

5x 16-bit LP timers

4x 32-bit timers

Dual Arm® Cortex®-A35 up to 1.5 GHz

L1 32 Kbytes I/ 32 Kbytes D NEON SIMD MPE

TrustZone®

512 Kbytes L2 cache

Arm® Cortex®-M33 @400 MHz

16 Kbytes D-Cache

16 Kbytes I-Cache

FPU / MPU / NVIC

TrustZone®

DDR4/LPDDR4 32-bit @ 1.2 GHz DDR3(L) 32-bit @ 1066 MHz

Shared RAM 640 Kbytes including 128 Kbytes Retention RAM

Backup RAM 8 Kbytes Boot ROM 128 Kbytes OTP fuse 12 Kbytes

Analog

3x 12-bit ADC 5 MSPS

Temperature sensor

Connectivity

2x 1Gbps ETH/TSN w/ switch

3x CAN-FD / TTCAN

3x SDIO3.0 / SD 3 eMMC 5.1

16-bit SLC NAND, 8-bit-ECC

2x Octo SPI, 8x SPI

5x UART, 4x USART

1Gbps ETH/TSN port

PCIe Gen2, 1 lane USB2.0 Host/Device HS or USB3.0 DRD

USB2.0 Host HS + HS PHY

USB Type-C connector support

8x I²C, 4x I3C, 3x I²S

Multimedia / AI

AI / NN HW Acceleration: up to 1.35 TOPS

3D GPU: OpenGL ES3.1 / Vulkan 1.3 / OpenCL 3.0

1080p60 H.264, VP8 Video Decoder / Encoder

24b RGB Disp. 1080p @ 60fps

LVDS Display 8 lanes with PHY

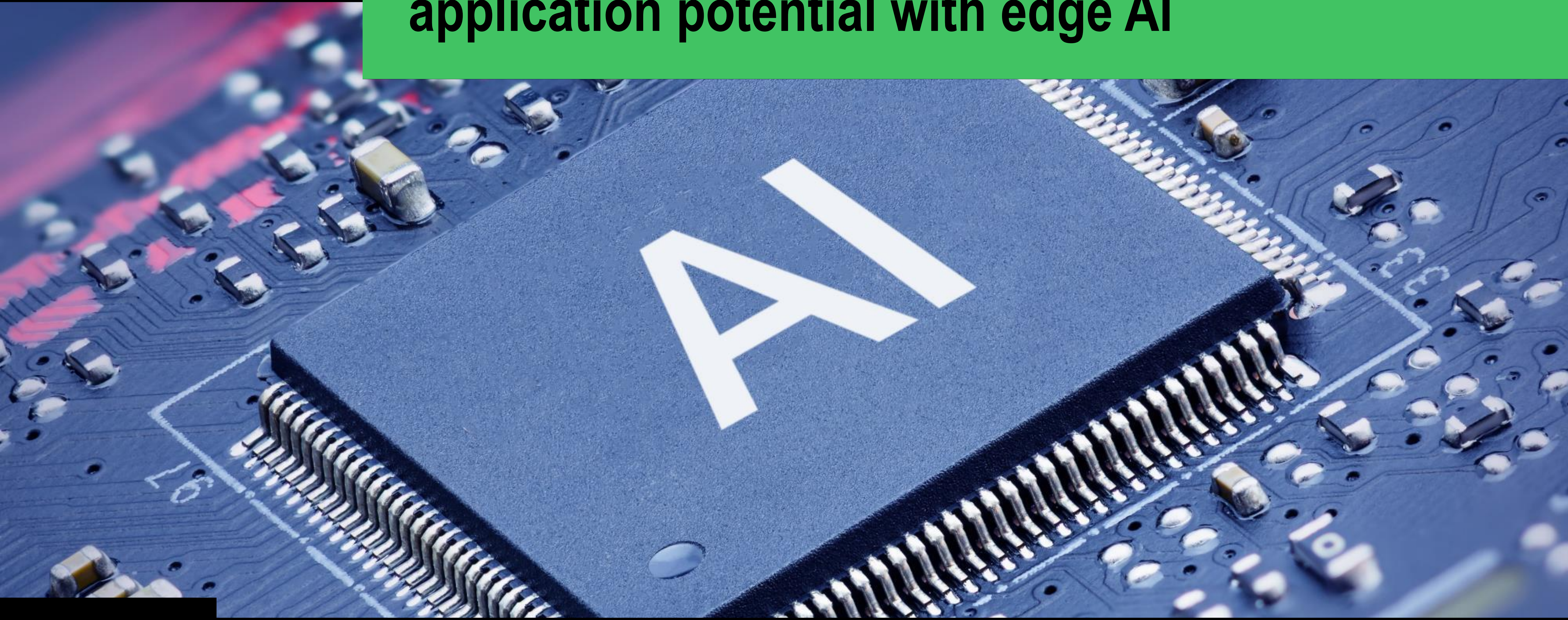
DSI Display 4 lanes with PHY

Camera I/F MIPI CSI-2 2 lanes

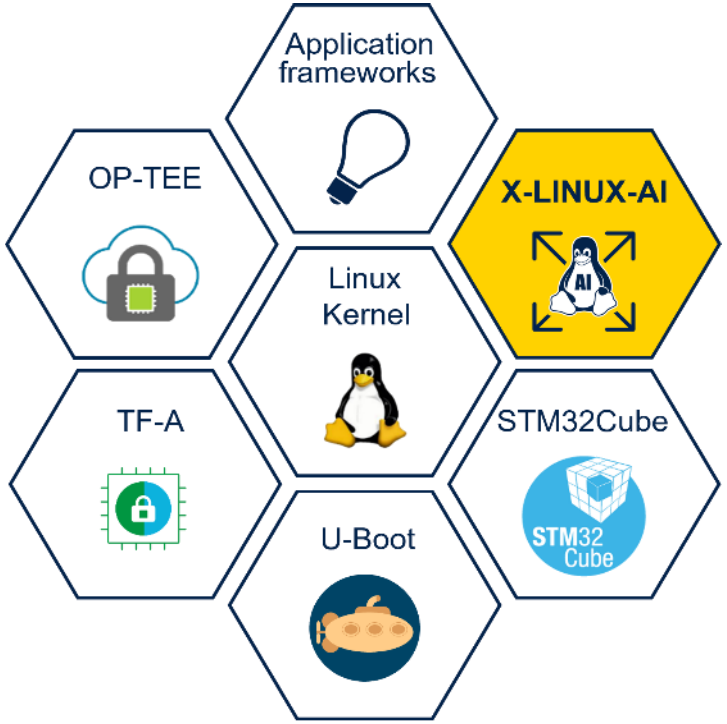
ISP (Camera Pipeline)

Camera I/F 16-bit Parallel

Neural processing unit (NPU) to unlock your application potential with edge AI



X-LINUX-AI



Application frameworks

OP-TEE

X-LINUX-AI

Linux Kernel

TF-A

STM32Cube

U-Boot

yocto PROJECT COMPATIBLE

All-in-one solution

All needed packages to bring AI to the edge

AI frameworks and Apps

- AI frameworks to execute Neural Network models
- Selection of AI application examples
- AI model benchmark application tools for STM32 MPU

Tooling framework

- Python3, Gstreamer, OpenCV to quickly develop applications

STM32 MPU agnostic

Compatible with all STM32 MPU series

OpenSTLinux Distribution

Delivered for OpenSTLinux

Tested and approved on STM32MPU discovery kit and evaluation boards

Seamlessly integrate AI in your STM32MP2 projects

1. Train

Bring your own model

MODEL

Trained Neural Network

TensorFlow

PyTorch

learn

MATLAB

ONNX

or

Start from ST Edge AI model zoo

Collection of pre-trained models and training scripts.

- Object detection
- Pose estimation
- Semantic segmentation
- ...

via

2. Benchmark and optimize

Get optimal performance on STM32MP2 NPU

ST Edge AI Core

Desktop version

ST Edge AI Developer Cloud

Cloud version

- Model **optimization**
- Model **quantization***
- **Benchmark** service
- Model **conversion**

*only available on Cloud version

3. Create your apps and deploy

Integrate your customized model in your application and deploy

X-LINUX-AI

Selection of AI application examples

OpenSTLinux Distribution

Delivered for OpenSTLinux

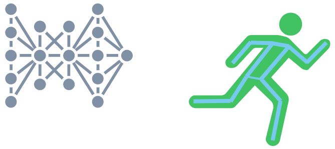
Tested and approved on STM32MPU Discovery Kit and Evaluation Boards

STM32MP25x

ST Edge AI model zoo

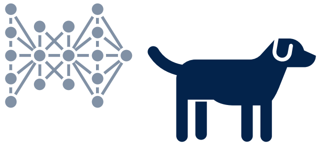
A collection of application-oriented models optimized for STM32

Pose estimation



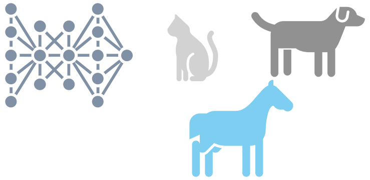
Human pose estimation

Image classification



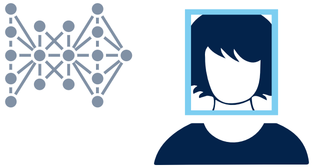
Computer vision

Semantic segmentation



Computer vision

Object detection



Computer vision

Hosted on Github

< I >

Model training scripts

- Scripts to train models with your own dataset
- Generate and validate your model

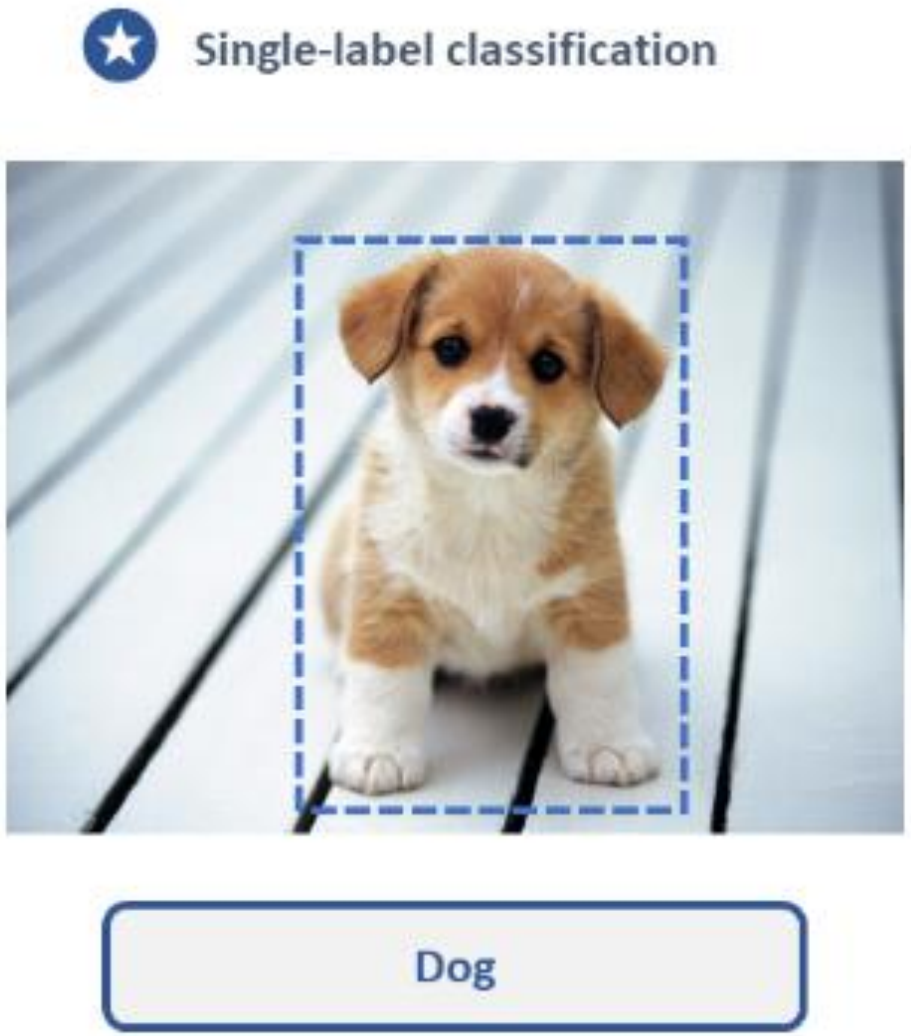
Image Classification

Model: MobileNetV2

- **Purpose:** Classifies images into a single category from a predefined set of classes. It doesn't detect where an object is, only what it is.

- **Example:** Given a photo of an animal, it would classify it as a "cat" or "dog."

- **MobileNetV2** is a convolutional neural network architecture that seeks to perform well on mobile devices. It is based on an inverted residual structure where the residual connections are between the bottleneck layers. The intermediate expansion layer uses lightweight depthwise convolutions to filter features as a source of non-linearity. As a whole, the architecture of MobileNetV2 contains the initial fully convolution layer with 3 filters, followed by 19 residual bottleneck layers.



Vision AI Model Summary

ST X-LINUX-AI https://www.st.com/en/embedded-software/x-linux-ai.html
ST Model Zoo https://github.com/STMicroelectronics/stm32ai-modelzoo
ST AI Application Wiki https://wiki.st.com/stm32mpu/wiki/Category:AI_-_Application_examples

Model Type	Functionality	Example Use Case	How it Works	Key Difference
Image Classification	Identifies and classifies objects in an image into predefined categories or classes.	Recognizing cats vs. dogs in a picture	The model processes the entire image and assigns a label based on the most likely category the image belongs to.	Focuses on a single object in an image and outputs class labels.
Object Detection	Detects and localizes multiple objects in an image, drawing bounding boxes around them and labeling them.	Detecting cars and pedestrians in traffic images	The model scans the image and identifies where objects are, assigns bounding boxes, and classifies each object.	Finds multiple objects with location data (bounding boxes) and classifies each object.
Semantic Segmentation	Classifies each pixel of the image to a category to understand object boundaries and shapes in the image.	Separating roads from buildings in satellite images	Each pixel is labeled with a class, creating a "segmented" output where different objects have distinct pixel regions.	Focuses on pixel-level classification for precise object boundaries.
Pose Estimation	Detects key points on a human body to determine the position and orientation of the person in the image.	Tracking a person's movements for fitness apps	The model identifies specific keypoints like joints (e.g., elbows, knees) and generates a skeleton of the person.	Detects body keypoints instead of object categories.

Avnet IoTConnect

Manage, Secure, Deploy

November 2024

About Avnet

Quick facts

- Founded in 1921
- Headquartered in Phoenix, Arizona
- $26.5B in revenue (FY23)
- AVT listed on the NYSE since 1960
- AVT listed on NASDAQ since 2018
- #163 on FORTUNE 500 (US) in 2022

15,300
Employees worldwide

1,925
Engineers around the world

2.8M+
Engineering community members

1M+
Customers in 140 countries

250+
Locations globally

$23.8B
Revenue

Avnet Investments

AVNET

CORE SEMI

softweb solutions
AN AVNET COMPANY

CLOUD APPLICATION DEVELOPMENT

Witekio
AN AVNET COMPANY

EMBEDDED SOFTWARE DESIGN SERVICES

TRIA
AN AVNET COMPANY

EMBEDDED MODULES & BOARDS

DESIGNED BY AVNET

SOLUTIONS DEVELOPMENT: ADVANCED APPLICATIONS GROUP

IoT Sales Team

A global specialized IoT team focused on providing unique hardware, software and cloud expertise to OEMs

Extensive line card

Semiconductors, IP&E, embedded systems, software and cloud

Hardware Edge Design

Technology selection and support provided by 800+ Field Application Engineers

Embedded Software Design

Design, develop, and integrate embedded OS, firmware, and application software

Cloud and Digital Design

Complete IoT solutions (cloud, apps, data insights) built on IoTConnect

Supply Chain and Logistics

Supply chain models to address each customer's priorities

Lifecycle Management

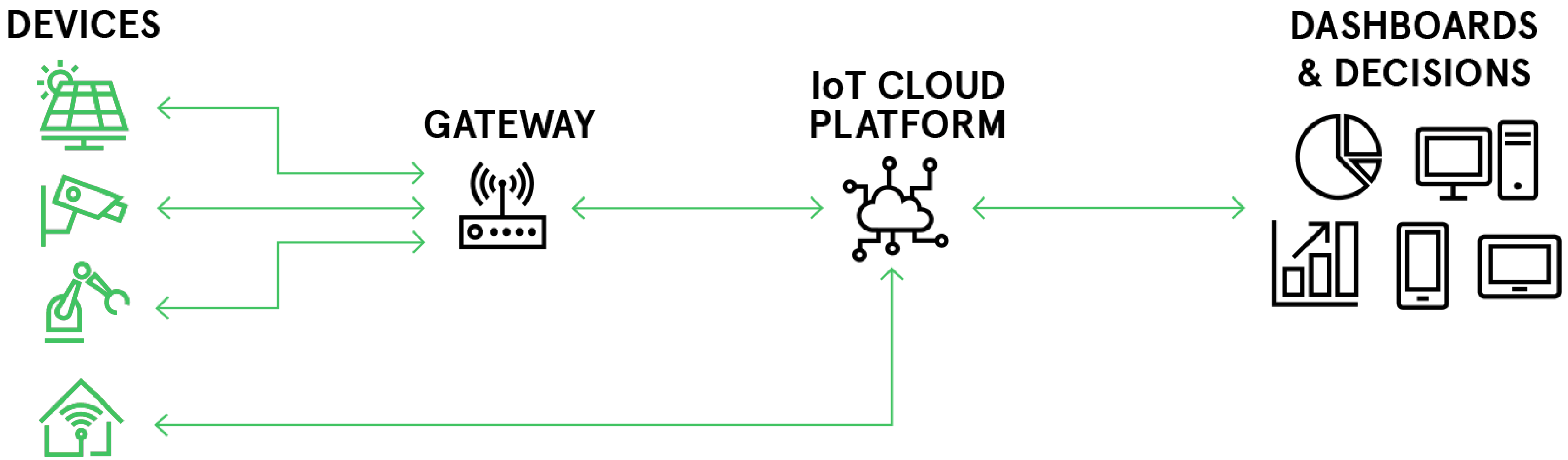
Digital Managed Services,
OTA updates, post sales support

Gives us Unmatched Capabilities

AVNET

The IoT Challenge

ΛVNET



DEVICES

GATEWAY

IoT CLOUD PLATFORM

DASHBOARDS & DECISIONS

Hardware & Firmware

ST

Cloud

aws

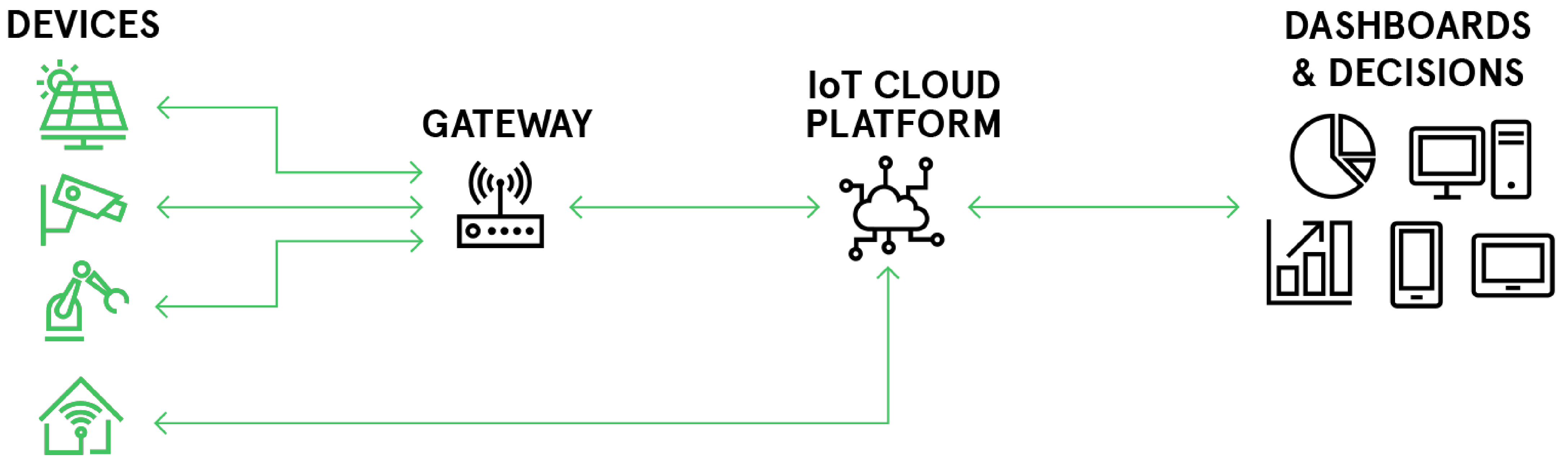
Back-End & Experience

SAP SIEMENS

workday ORACLE

IoT solutions require skills across multiple engineering disciplines

The IoT Challenge


DEVICES
GATEWAY
IoT CLOUD PLATFORM
DASHBOARDS & DECISIONS

Hardware & Firmware **Cloud** **Back-End & Experience**

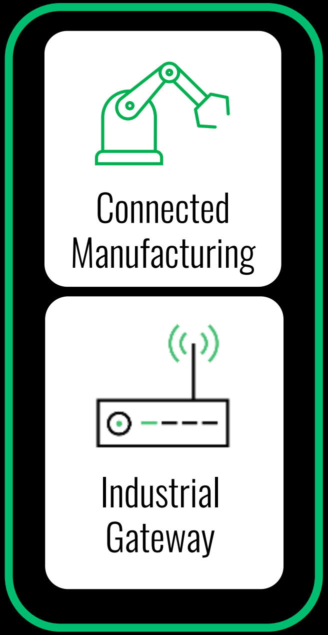
/IOTCONNECT®

IoT solutions require skills across multiple engineering disciplines

/IOTCONNECT®

/IOTCONNECT®

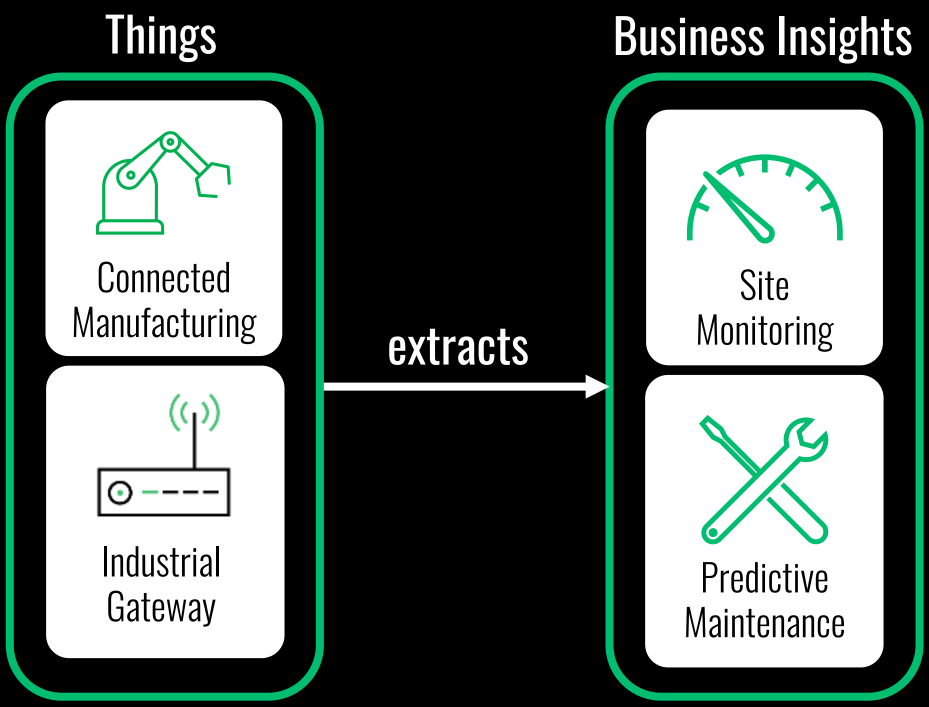
Things



Connected Manufacturing

Industrial Gateway

/IOTCONNECT®



Things

Connected Manufacturing

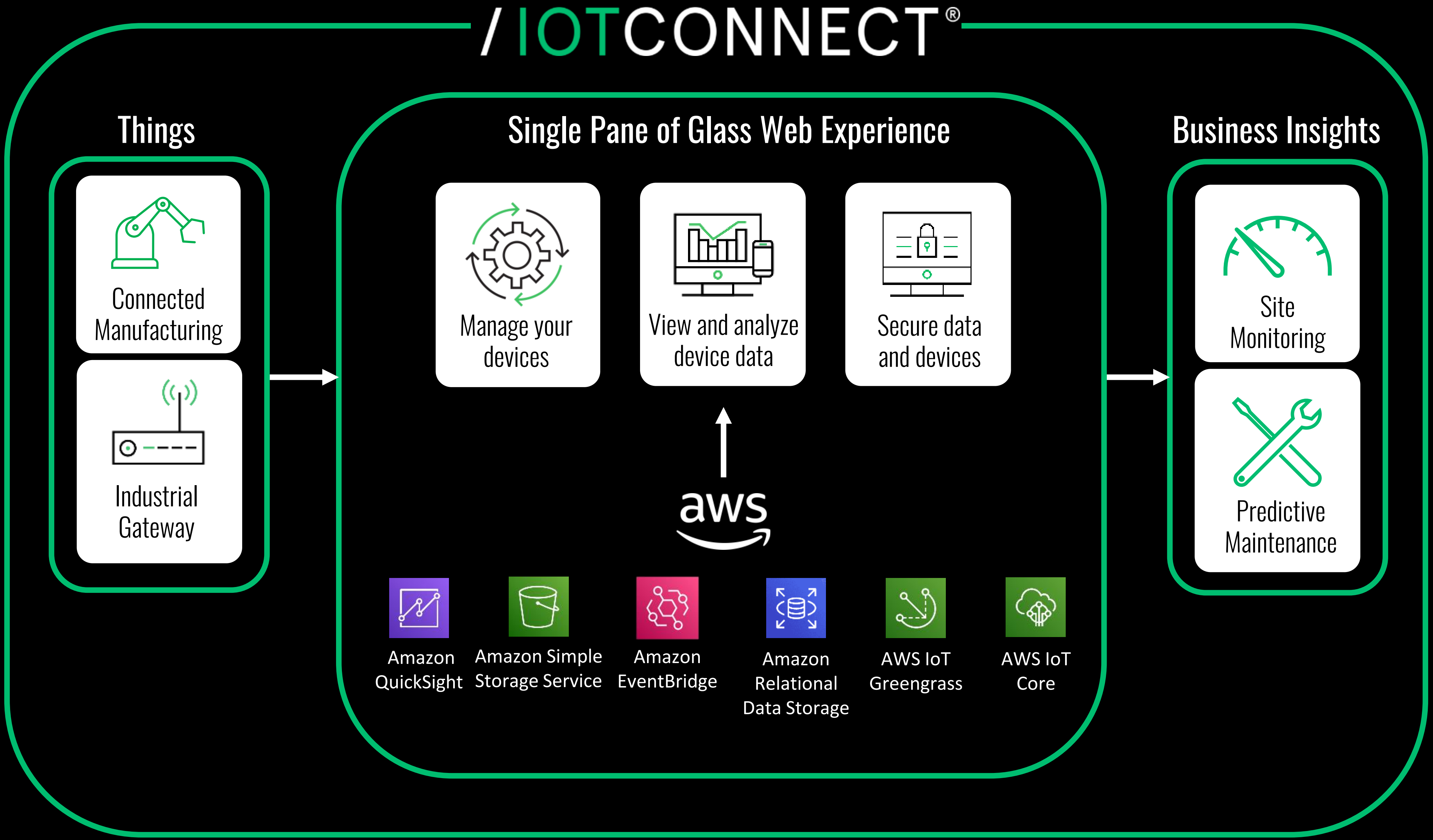
Industrial Gateway

extracts

Business Insights

Site Monitoring

Predictive Maintenance



/IOTCONNECT®

Things

Connected Manufacturing

Industrial Gateway

Single Pane of Glass Web Experience

Manage your devices

View and analyze device data

Secure data and devices

aws

- Amazon QuickSight
- Amazon Simple Storage Service
- Amazon EventBridge
- Amazon Relational Data Storage
- AWS IoT Greengrass
- AWS IoT Core

Business Insights

Site Monitoring

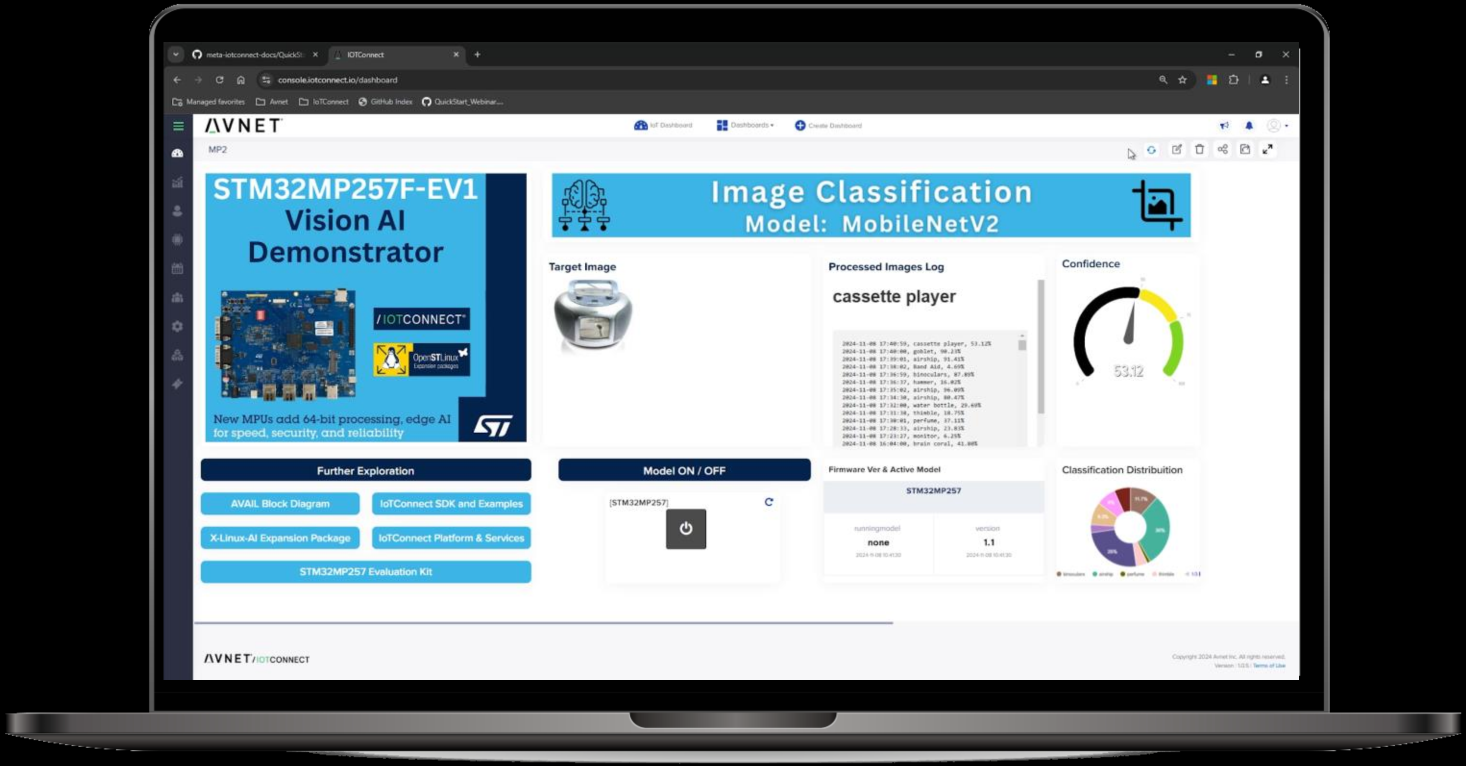
Predictive Maintenance

/ IOTCONNECT®

ST MP2 VisionAI Use Case

ST MP2 AI
Evaluation Kit

+


meta-iotconnect-docs/QuickSt
IOTConnect
console.iotconnect.io/dashboard
Managed favorites
Avnet
IoTConnect
GitHub Index
QuickStart_Webinar...
AVNET
IoT Dashboard
Dashboards
Create Dashboard
MP2
/IOTCONNECT
OpenSTLinux
Expansion packages
Further Exploration
AVAIL Block Diagram
IoTConnect SDK and Examples
X-Linux-AI Expansion Package
IoTConnect Platform & Services
STM32MP257 Evaluation Kit
Model ON / OFF
[STM32MP257]
53.12
AVNET/IOTCONNECT

STM32MP257F-EV1
Vision AI
Demonstrator

New MPUs add 64-bit processing, edge AI for speed, security, and reliability

Image Classification
Model: MobileNetV2

Target Image

Processed Images Log

cassette player

```
2024-11-08 17:40:59, cassette player, 53.12%
2024-11-08 17:40:00, goblet, 90.23%
2024-11-08 17:39:01, airship, 91.41%
2024-11-08 17:38:02, Band Aid, 4.69%
2024-11-08 17:36:59, binoculars, 87.89%
2024-11-08 17:36:37, hammer, 16.02%
2024-11-08 17:35:02, airship, 96.09%
2024-11-08 17:34:30, airship, 80.47%
2024-11-08 17:32:00, water bottle, 29.69%
2024-11-08 17:31:30, thimble, 18.75%
2024-11-08 17:30:01, perfume, 37.11%
2024-11-08 17:28:33, airship, 23.83%
2024-11-08 17:23:27, monitor, 6.25%
2024-11-08 16:04:00, brain coral, 41.80%
```

Confidence

Firmware Ver & Active Model

STM32MP257

runningmodel	version
none	1.1

Classification Distribuition

Resource Links

- Purchase STM32MP257-EV1
- Webinar QuickStart on GitHub
- Unabridged QuickStart on GitHub
- IoTConnect Free Trial
- Additional ST QuickStart Guides
- IoTConnect Knowledgebase
- Link to all Resources