



# Introducing the i.MX 93: Your “Go-To” Processor for Embedded Vision

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NXP Semiconductors



- Introduction to NXP application processors
- Introduction to i.MX 93
  - Architecture
  - Features
  - Target applications
- i.MX 93 machine vision features
- Machine vision software enablement flow and demo

# Scalable Compute Platforms



# i.MX 93 Applications Processors Family

## i.MX 6

- 12 product families
- Offers software and pin-pin compatibility between families for easy compute scalability
- Arm® v7-A processors



## i.MX 8 Family

Advanced Graphics, Vision & Performance

## i.MX 8M Family

General Purpose Edge Computing

## i.MX 8ULP Family

Ultra Low Power with Graphics

## i.MX 8X Family

Safety certifiable & Efficient Performance

## i.MX 7 Family

Flexible Efficient Connectivity



## Future i.MX 9 Families

Industrial, IoT & Automotive Edge

## i.MX 9xx Family



## i.MX 95 Family



## i.MX 93 Family

General Purpose Edge Computing

Arm® v8.2-A  
(32-bit/64-bit)

A55

M33

NPU



## i.MX 9xx Family

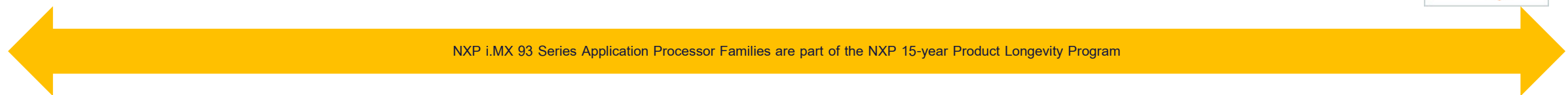


# Reliable Processors for Long-life Platforms

- NXP's Product Qualification program considers conditions experienced by the processor when running in customer application

Qualification Level	Characteristics	Temperature Range
Commercial or Consumer	SoC is 50% on for 5-year life	Typically: 0°C to +95°C Tj
Industrial (Longest operating life)	SoC is 100% on for 10-year life	Typically: -40°C to +105°C Tj Extended: -40°C to +125°C Tj
Automotive	SoC is 10% on for 15-year life	Typically: -40°C to +125°C Tj

- NXP's Product Longevity program goal is to ensure stable supply of products for automotive and industrial designs



# i.MX 93 Family – Differentiated Features

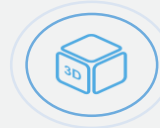


**EDGELOCK®**  
SECURE ENCLAVE

**MULTI-SENSORY  
EXPERIENCES**



STREAMING  
MEDIA



RICH 2D & 3D  
GRAPHICS



ADVANCED  
AUDIO



VOICE  
PROCESSING



TOUCH  
SENSING



VISION



**ENERGY FLEX  
ARCHITECTURE**  
WITH HETEROGENEOUS  
DOMAIN COMPUTING

**i.MX 93**  
Applications  
Processors Family



**INHERENTLY  
INTELLIGENT**  
INTEGRATED ML  
ACCELERATORS

**SCALABLE COMPUTE**

HIGH PERFORMANCE – FROM SINGLE TO MANY CORE CONFIGURATIONS



**SOFTWARE**



**ESSENTIAL  
CONNECTIVITY**

**DEVELOPMENT KITS**



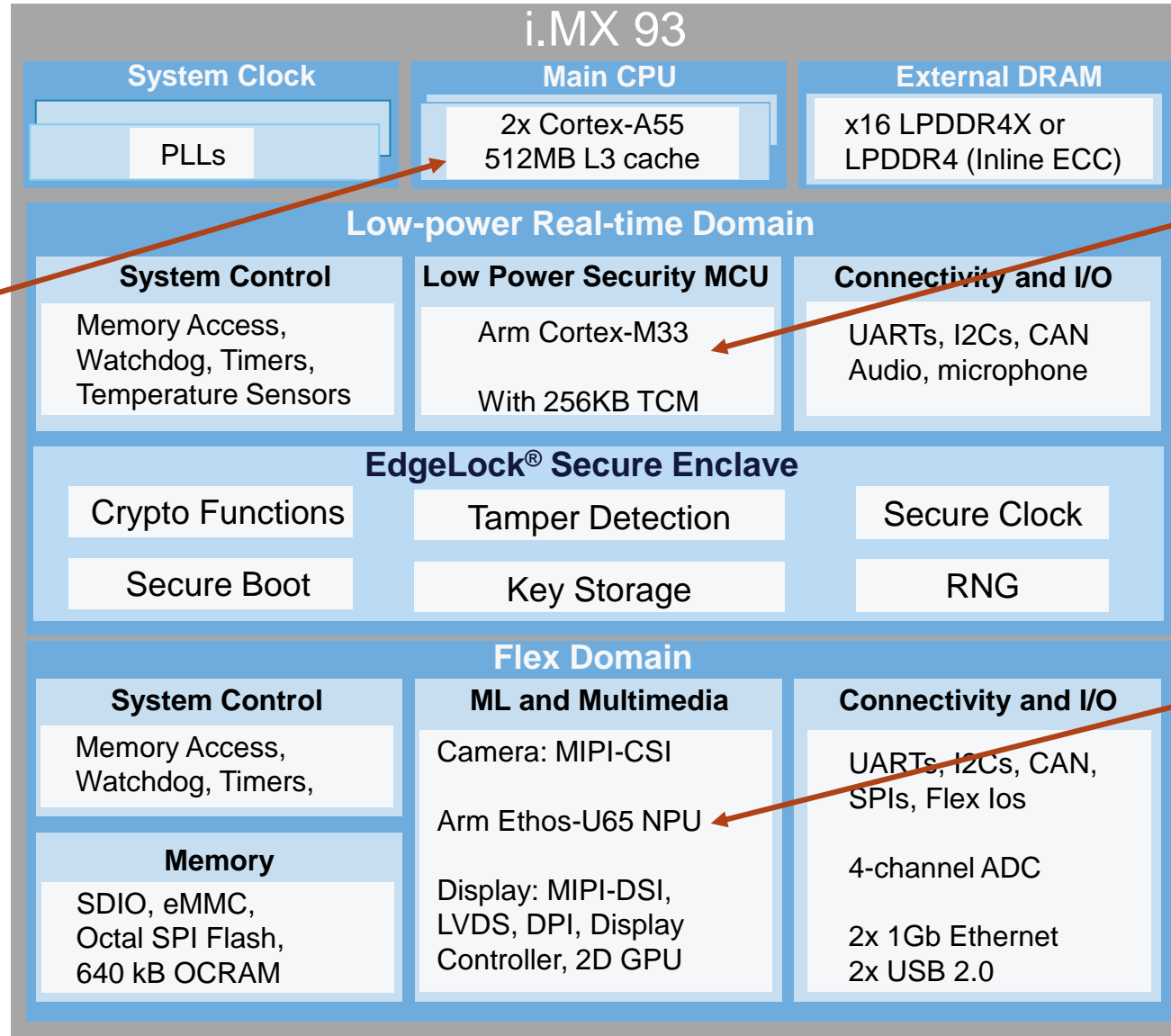
**BUILT-IN MCU!**  
REAL TIME RESPONSE  
FOR THE REAL WORLD  
ALWAYS-ON, LOW POWER SENSING

**TURN-KEY SOLUTIONS**

**FIELD APPLICATIONS ENGINEERS & CUSTOMER SUPPORT TEAMS**

# i.MX 93 Microprocessor with ML & Vision Engines

- 2x Arm® Cortex® A55  
@ 1.7 GHz**
- Speech command recognition
  - Object detection and classification
  - Gesture recognition



- 1x Cortex-M33  
@ 250 MHz**
- Keyword detection
  - Anomaly detection

- 1x Arm® Ethos-U65®  
@ 1 GHz**
- Speech command recognition
  - Object detection and classification
  - Gesture recognition

[www.nxp.com/imx93](http://www.nxp.com/imx93)



# i.MX 93 Family: Vision Applications Across Segments

- Keys features used in vision applications
  - Camera interface: MIPI-CSI
  - Other Interfaces: USB, Ethernet, Wi-Fi connectivity and other low-speed interfaces (SPI, UARTs etc)
  - Processing: A55, NPU, M33

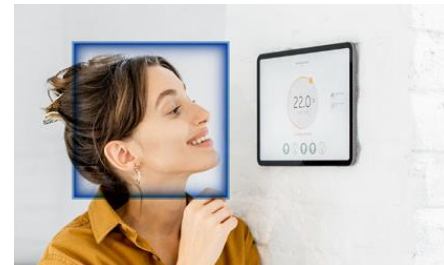
## Industrial Automation

- Industrial Machine vision
- Industrial scanning/printing



## Smart Home

- Smart doorbell
- Smart lock
- Smart home hub/ Hue Bridge



## Smart City

- Smart lighting
- Traffic control



## Automotive

- Driver Monitoring System (DMS)
- Object Monitoring System (OMS)

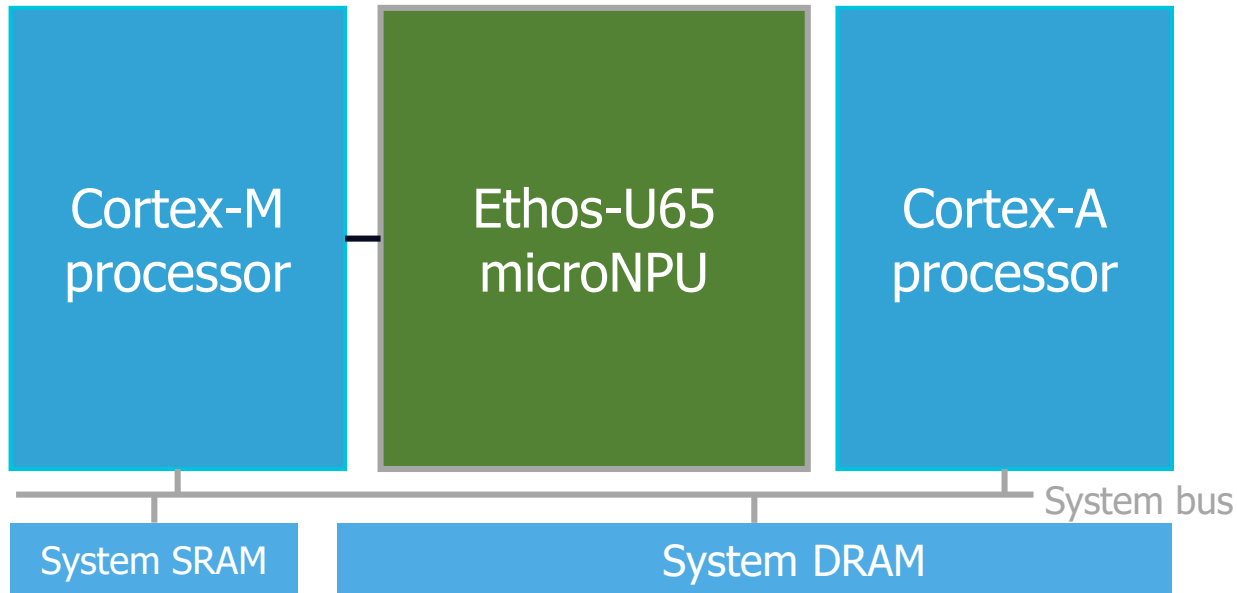




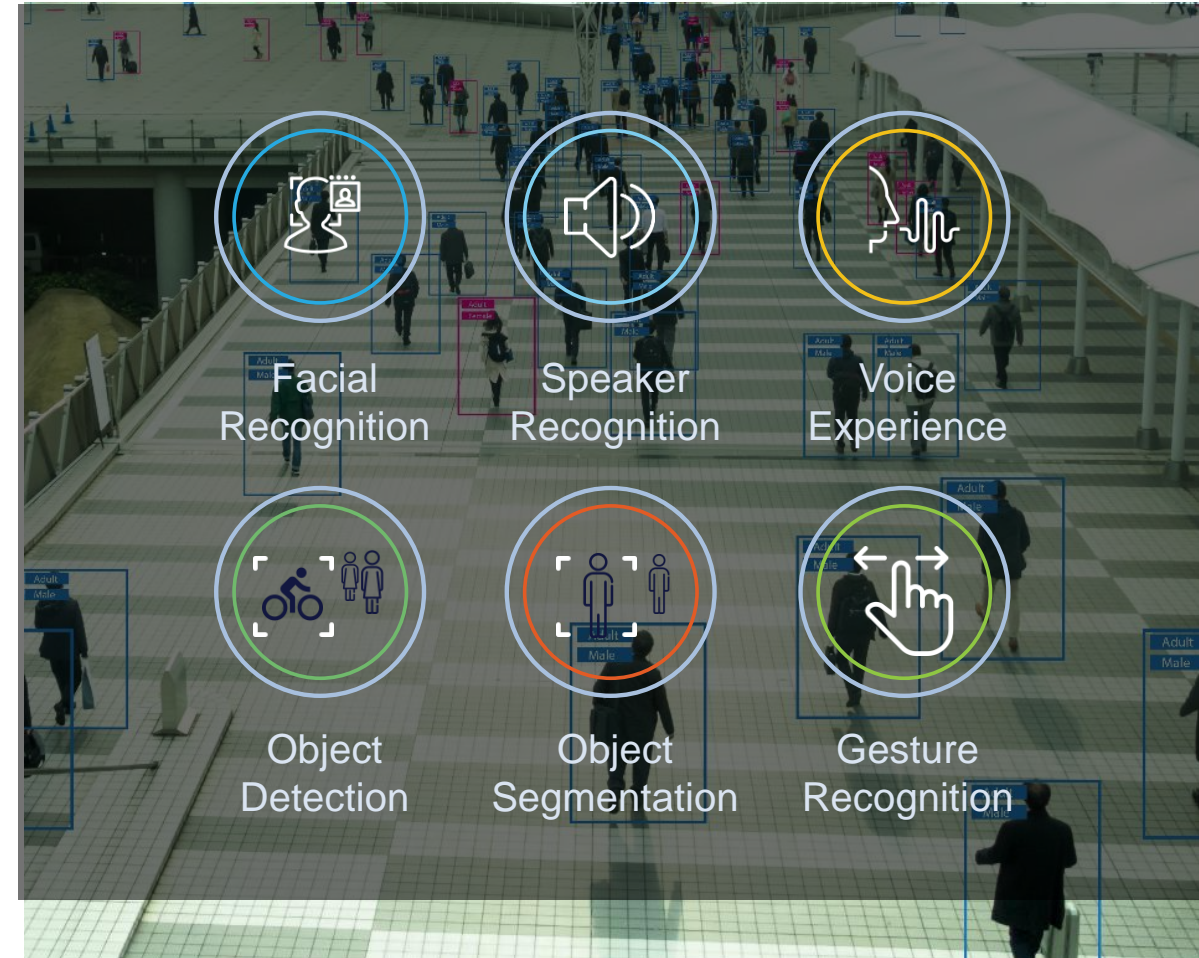
**AL/ML  
NPU (Neural Processing Unit)**



# Expanding Edge ML with ARM® Ethos™-U65

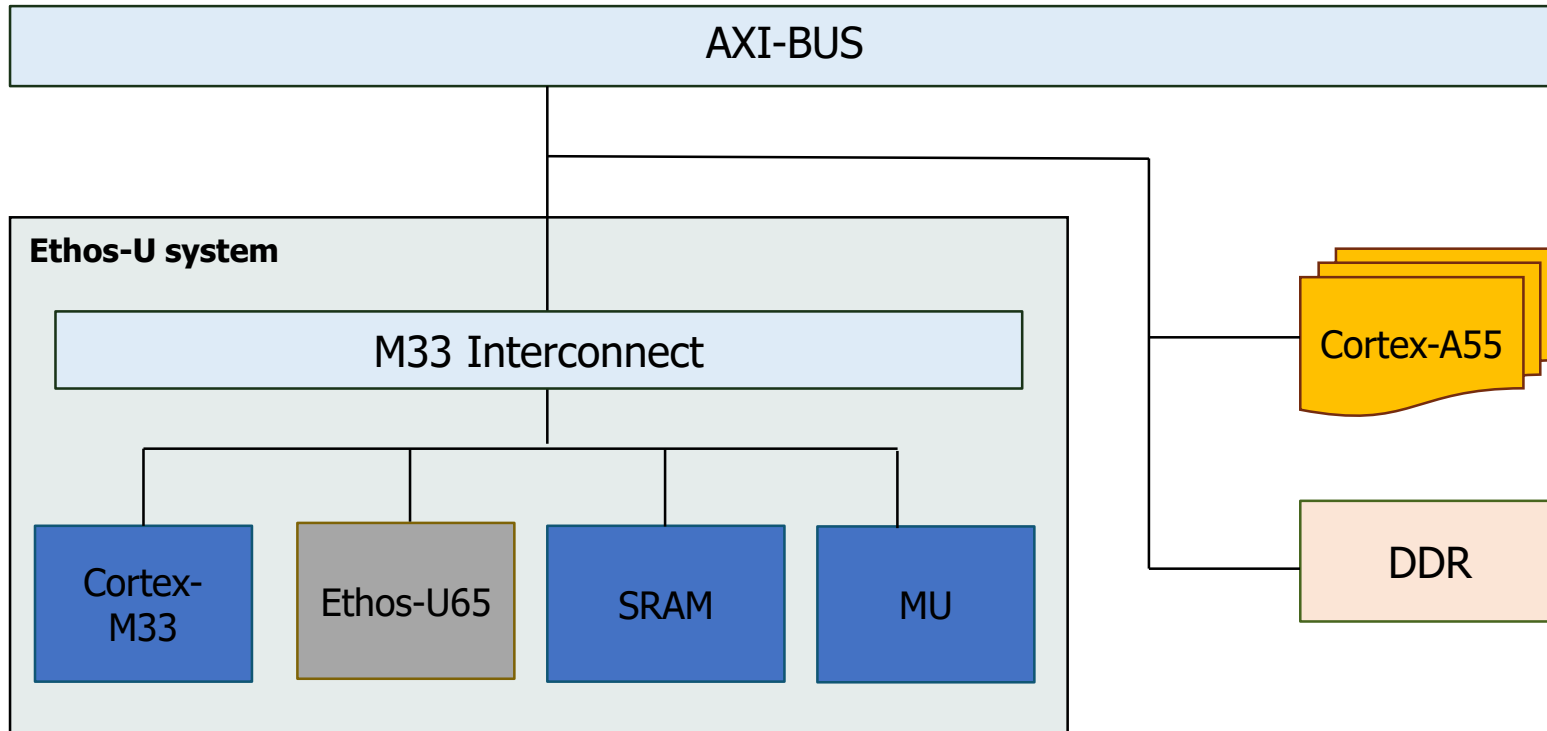


- High efficiency and small memory footprint
- HW acceleration for high compute NN + Cortex-M for other operations
- Model compression and on-the-fly weight decompression
- Comprehensive software and tools with NXP's eIQ® ML Software Development Environment



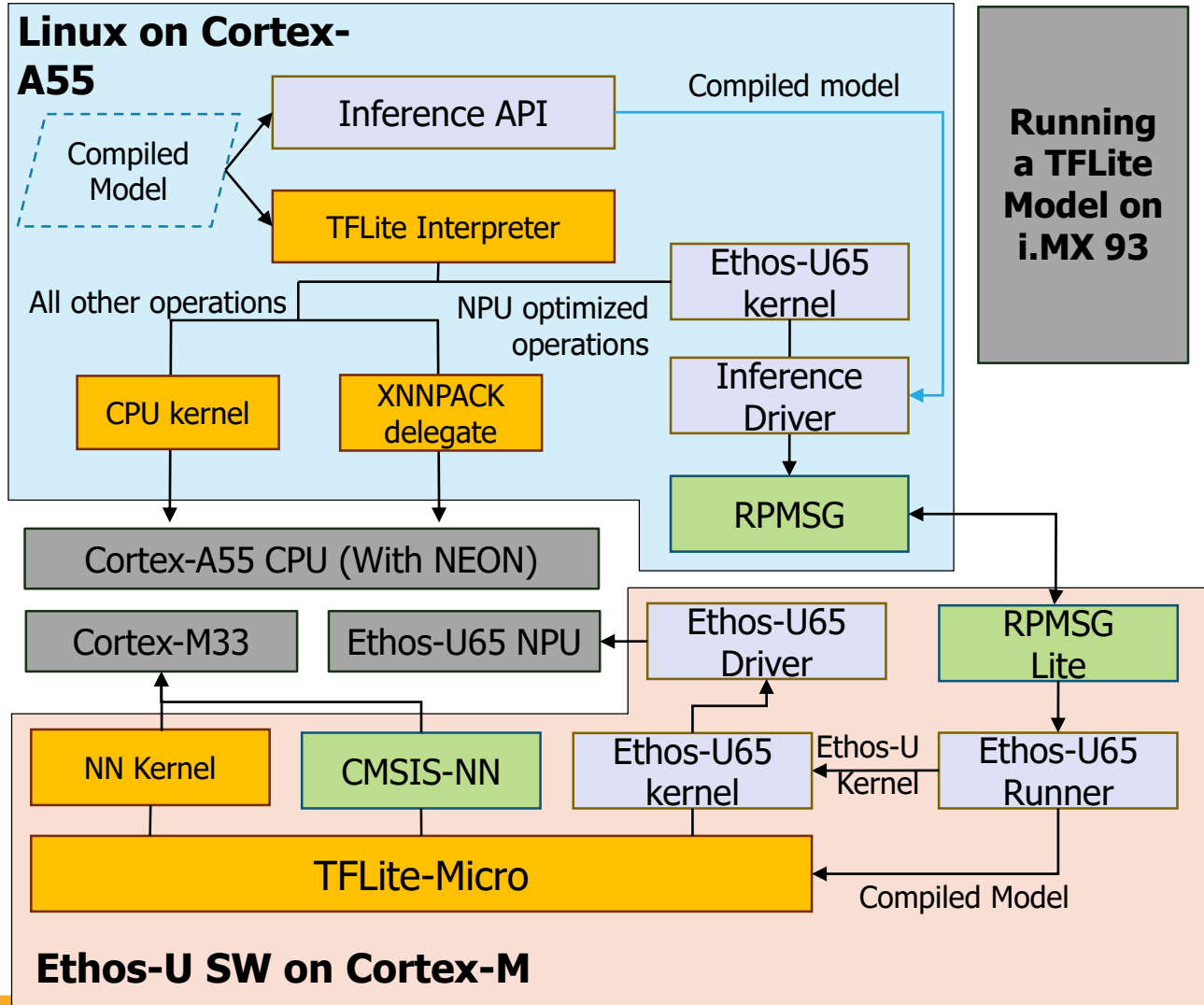
**BRINGING MCU-CLASS  
ML EFFICIENCY TO THE CORTEX-A WORLD**

# Ethos-U65 Hardware Architecture



- The Ethos-U system includes Cortex-M, Ethos-U65, SRAM and Messaging Unit (MU).
- Ethos-U65 is controlled by Cortex-M. Cortex-A has no direct access with Ethos-U NPU.
- Communication between CPUs is through DDR memory and the MU.
- Ethos-U NPU can access both DDR and SRAM over embedded DMA interface.
- Model weights, bias, input and output feature maps are stored in DDR
- SRAM size is 384 KB

# Ethos-U65 Software Architecture

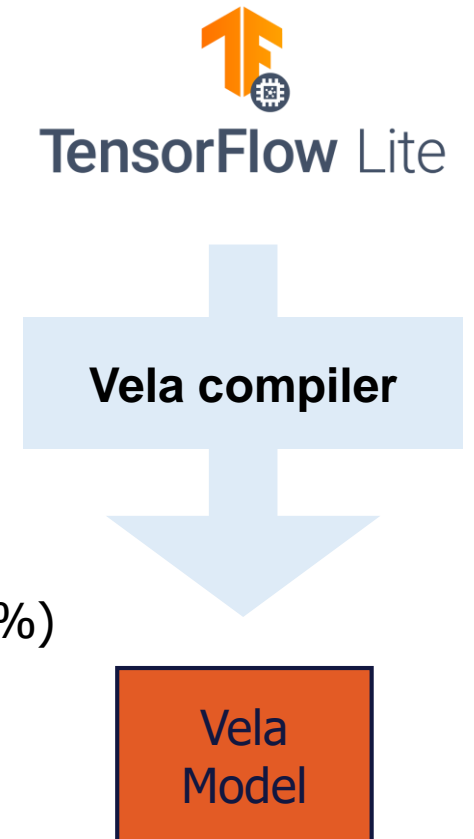


Running a TFLite Model on i.MX 93

- **TensorFlow Lite (TFLite) interpreter** or **Inference API** to run the model on NPU:
  - TFLite interpreter: NPU optimized operations on NPU, all other operations on Cortex-A55.
  - Inference API: all operations not supported by NPU will be fallback to Cortex-M core.
- Requires precompiling a model to be able to run on the NPU
  - Non-compiled model will run on Cortex-A55 core only.
- Users can compile models using the **Arm Vela compiler** or **NXP eIQ Portal**.

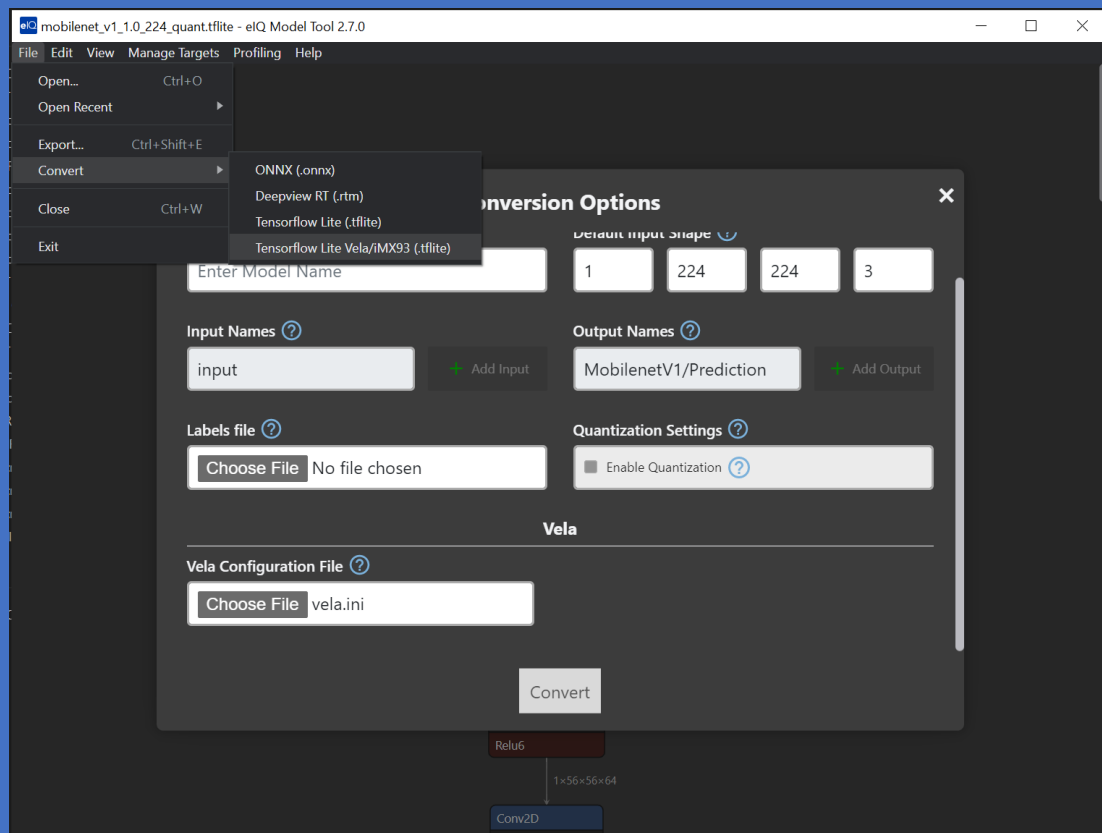
# The ARM Vela Compiler

- ARM Vela compiler tool **converts a quantized TFLite model and exports it to an optimized version** that can be run on the Ethos-U65 NPU (Vela model).
- Conversion is one way: TFLite → Vela model only
- Converts TFLite operators to custom operators that can run on the NPU
  - Unsupported TFLite operators will run on CPU
- Additionally, tool compresses model to reduce model size (~70%) and SRAM size (~90%)
- Tool is **free to download** and open-source: <https://github.com/nxp-imx/ethos-u-vela>



# Compiling a Model for i.MX 93 SoC

## Method 1: Use eIQ Portal's Model Viewer

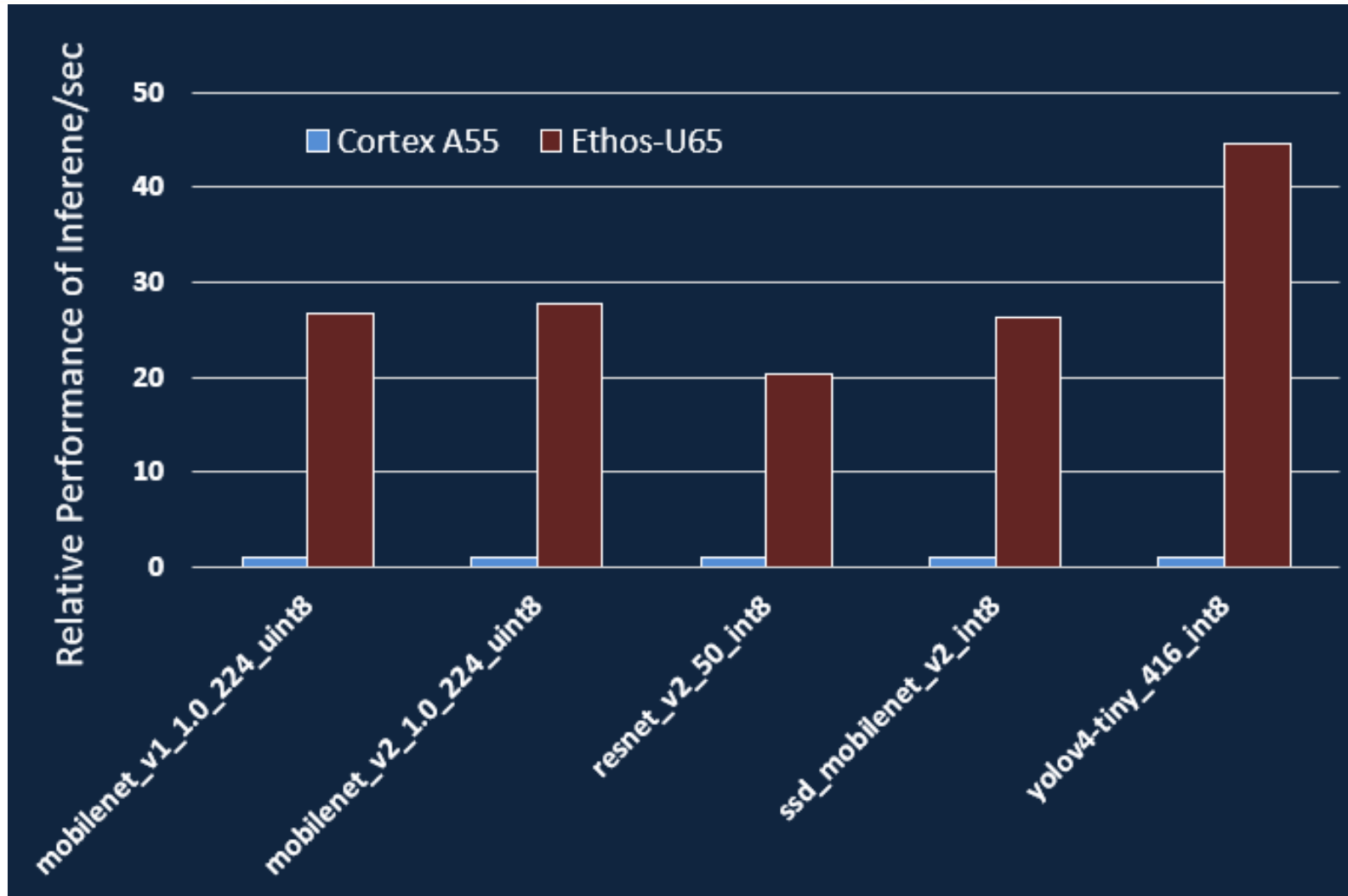


## Method 2: Use the Command Line Tool

```
$ git clone https://github.com/nxp-imx/ethos-u-vela.git
$ cd ethos-u-vela
$ git checkout lf-5.15.71_2.2.0
$ pip3 install .
$ vela mobilenet_v1_1.0_224_pb_int8.tflite
```

**Both methods create a Vela model file that can be used on the i.MX 93's NPU**

# NPU Performance Increase for Quantized Models

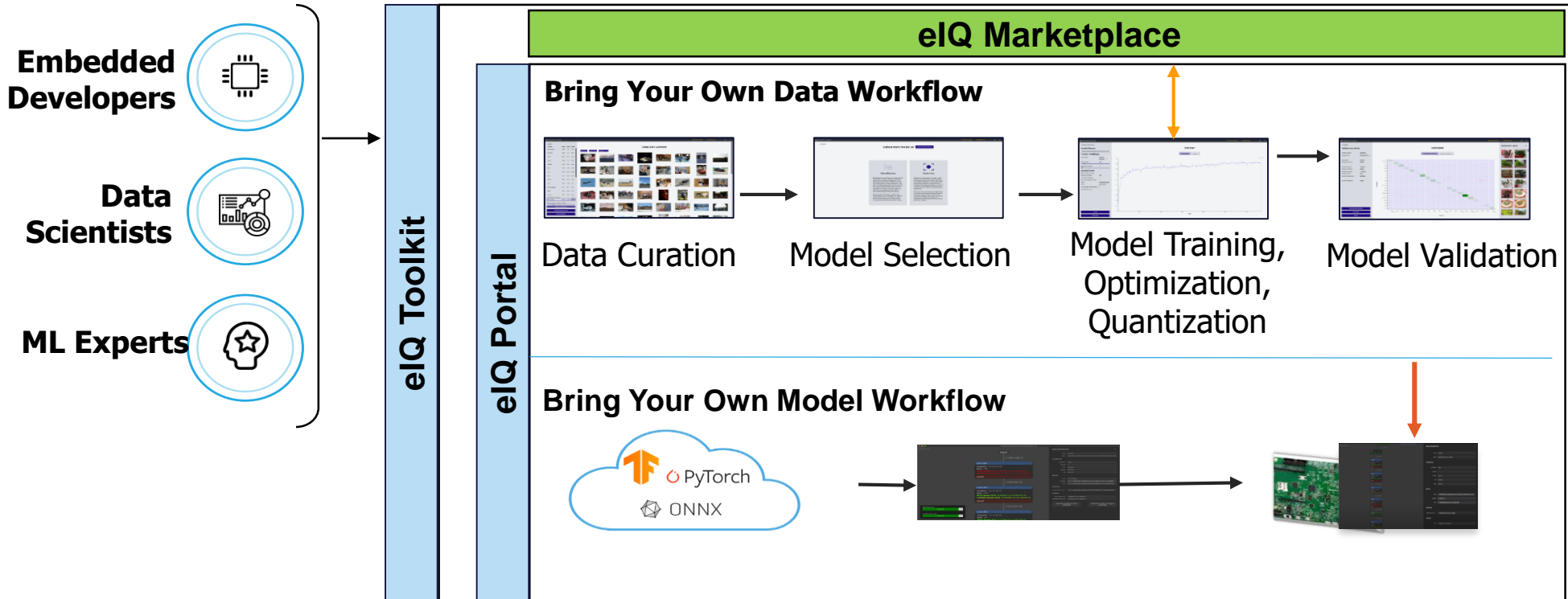


- Measured inference/sec on i.MX 93 with NPU and Cortex A55 running at 1 GHz

# Machine Vision Software Enablement



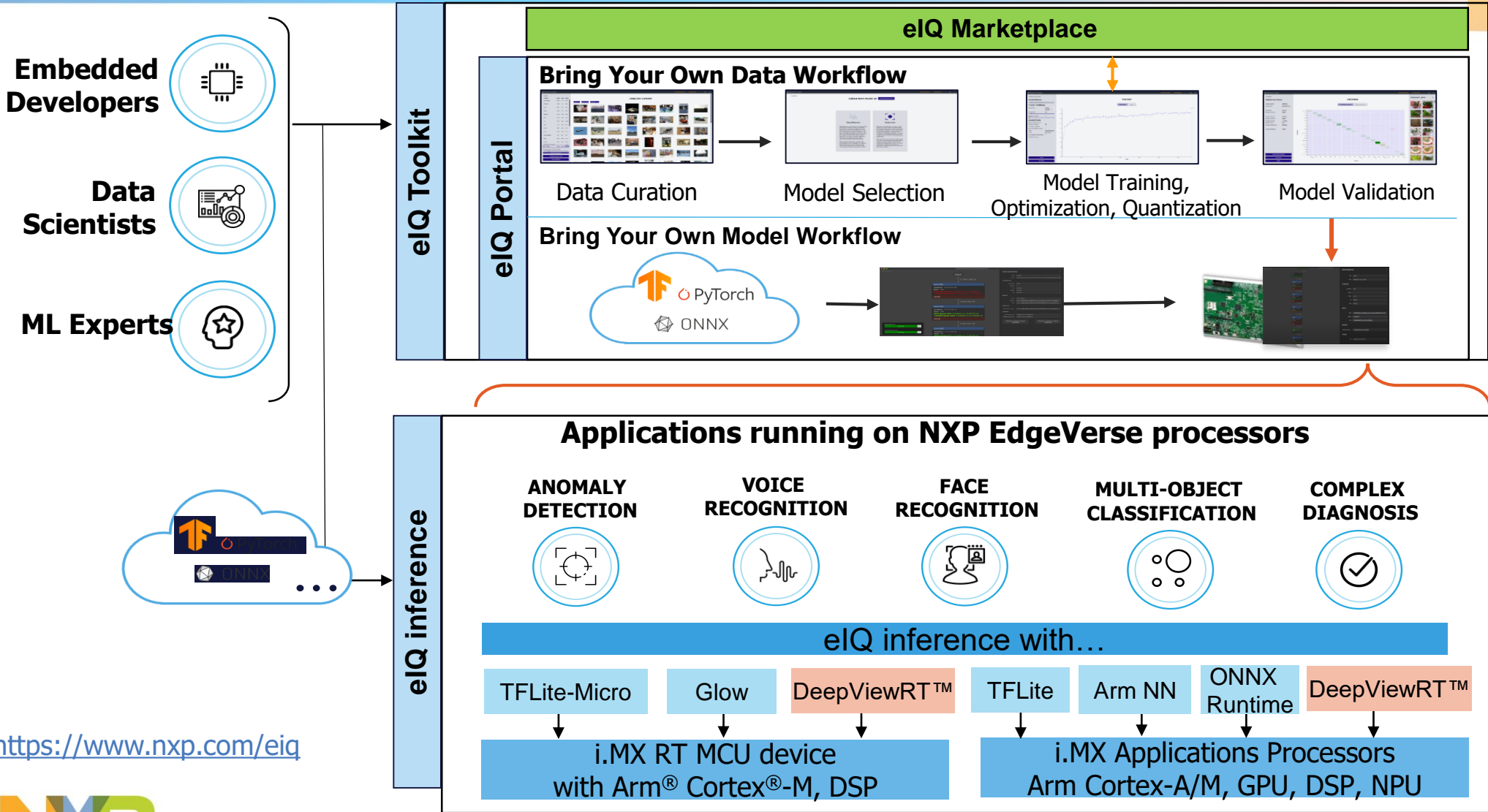
# eIQ ML SW Development Environment



## Solutions and Services from NXP and NXP Eco-System Partners

- ML Applications
- Optimized Models
- Optimization Tools and Modules
- Development tools
- Datasets
- Training
- Sensor solutions

# eIQ ML SW Development Environment



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- ....

<https://www.nxp.com/eiq>



# eIQ ML SDE Inference Engine Options

## NXP eIQ® ML Software Development Environment

### Inference Engines and Libraries for Neural Network Model Deployment

**DeepViewRT**

**TensorFlow Lite** for Microcontrollers

**GLOW**

**armNN**

**DeepViewRT**

**TensorFlow Lite**

**ONNX RUNTIME**

Arm® Cortex®-M

DSP

i.MX RT1050  
i.MX RT1060  
i.MX RT1064  
i.MX RT1160  
i.MX RT1170

i.MX RT600

i.MX RT600

Microcontroller Compute Engines

DSP

GPU

NPU

Arm® Cortex®-A

i.MX 8M Plus

i.MX 8M Plus  
i.MX 8M  
i.MX 8M Nano

**i.MX 93**  
i.MX 8M Plus

**i.MX 93**

i.MX 8M Plus  
i.MX 8M  
i.MX 8M Nano  
i.MX 8M Nano UL  
i.MX 8M Mini

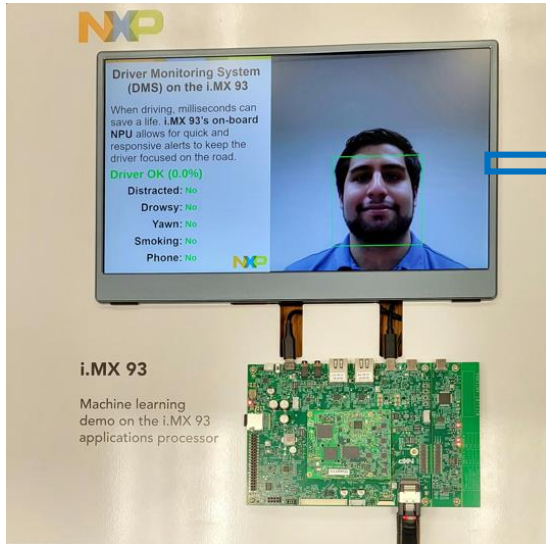
Applications Processor Compute Engines

\* Planned

• Additional support for devices not listed can be available or requested

# Machine Vision Use Case & Demos

# Sample Enablement Flow Video and Demo



Detects movement of car driver to estimate alertness to drive

## Driver Monitoring System (DMS) on the i.MX 93

When driving, milliseconds can save a life. **i.MX 93's on-board NPU** allows for quick and responsive alerts to keep the driver focused on the road.

**Driver OK (0.0%)**

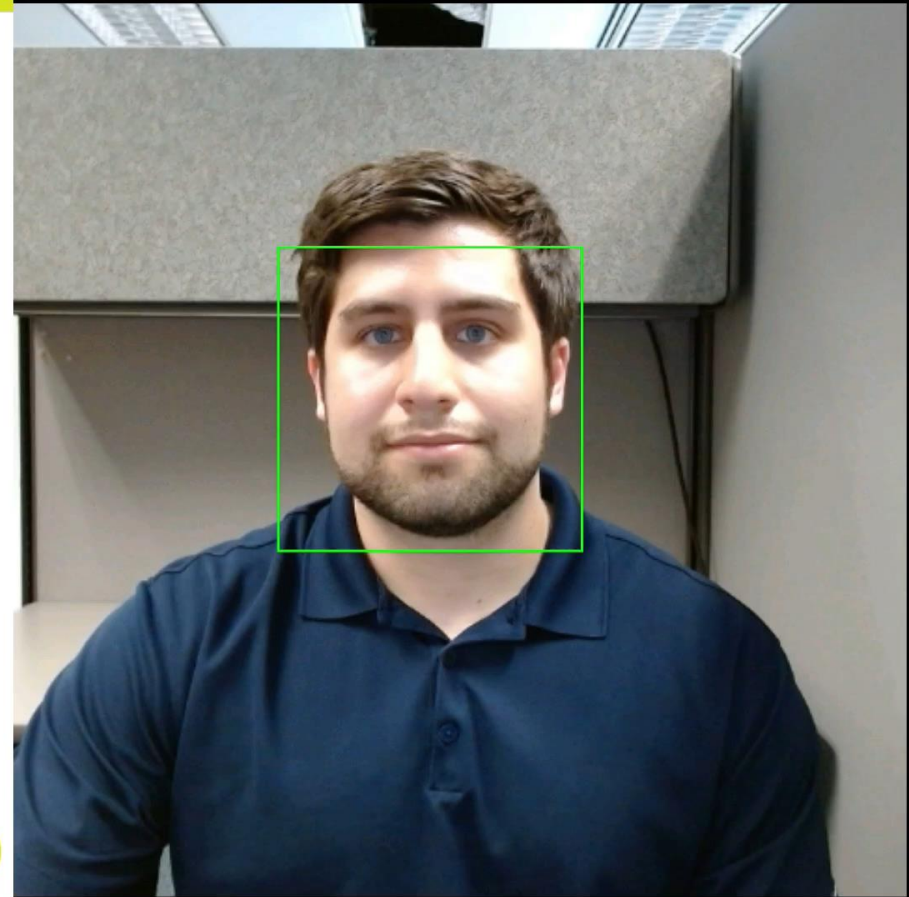
**Distracted: No**

**Drowsy: No**

**Yawn: No**

**Smoking: No**

**Phone: No**



- NXP just launched the i.MX 93 applications processor family - first in next generation i.MX 9 series
- i.MX 93 enables customers to develop cost-optimal solution for low-/mid-end vision applications using following features
  - Hardware: NPU, MIPI-CSI interface
  - Software: eIQ™ toolkit
  - Enablement: plethora of reference demos targeting machine vision application
- Please email [Srikanth.Jagannathan@nxp.com](mailto:Srikanth.Jagannathan@nxp.com) and [Ali.Ors@nxp.com](mailto:Ali.Ors@nxp.com) for any questions related to i.MX 93 samples/EVKs/eIQ™/ML Demos etc.

- i.MX 93 product page: [www.nxp.com/imx93](http://www.nxp.com/imx93)
- i.MX 93 evaluation kit (EVK) page: [www.nxp.com/imx93evk](http://www.nxp.com/imx93evk)
- eIQ™ page [www.nxp.com/EIQ](http://www.nxp.com/EIQ)
- **Please visit NXP booth for more demos and discussion**

**Thank You**