Design an Eye-Catching Vision System for Machine Learning with the i.MX 8M Plus Applications Processor

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with an introduction of Markus Levy, Director of Machine Learning Technologies – NXP Semiconductors

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SECURE CONNECTIONS FOR A SMARTER WORLD

WHY MACHINE LEARNING IS MOVING TO THE EDGE

Safeguard Privacy

Better User Experience

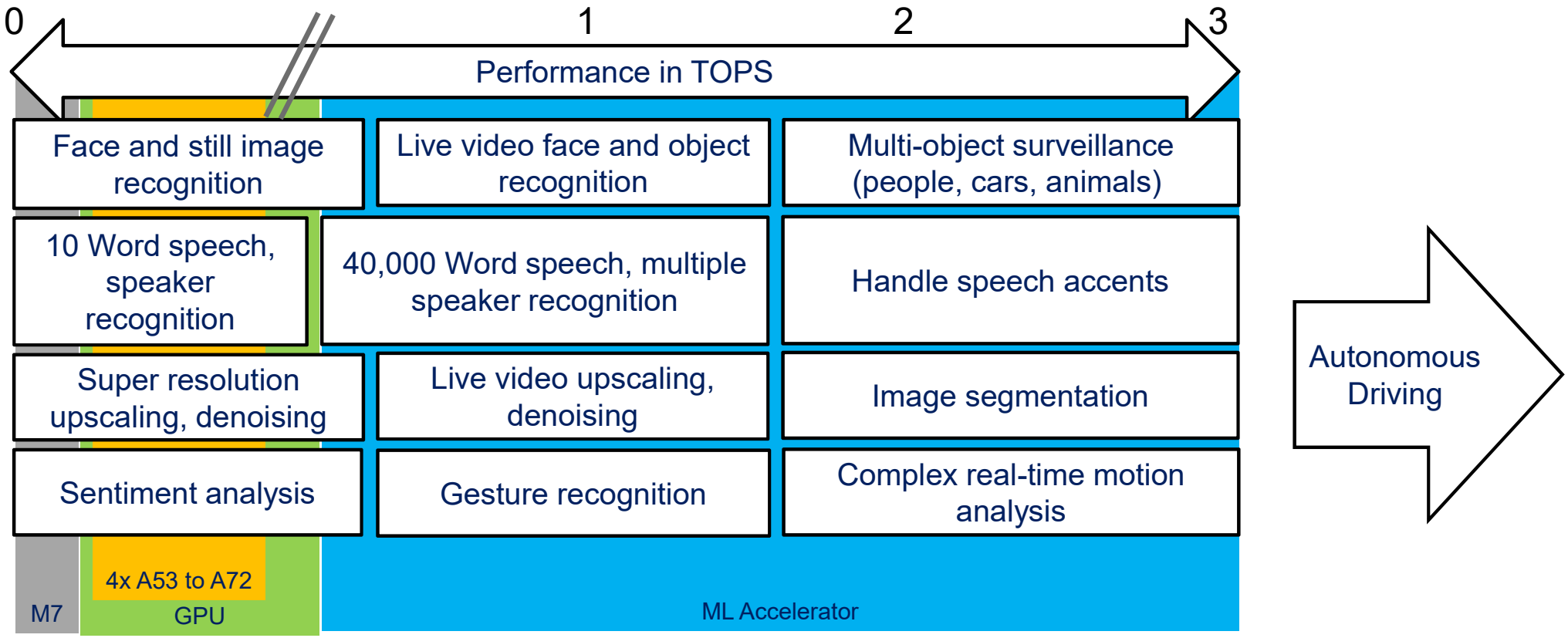
Higher Reliability

Enable Real Time

Increase Security

Reduce Cloud Costs Including: Bandwidth, Processing, Storage

MACHINE LEARNING USE CASES



I.MX 8M PLUS MACHINE LEARNING COMPUTE ENGINES

Machine Learning Accelerator (1GHz)

- Primary Use: Multi-camera classification/detection

Quad Arm® Cortex-A53 (1.8GHz)

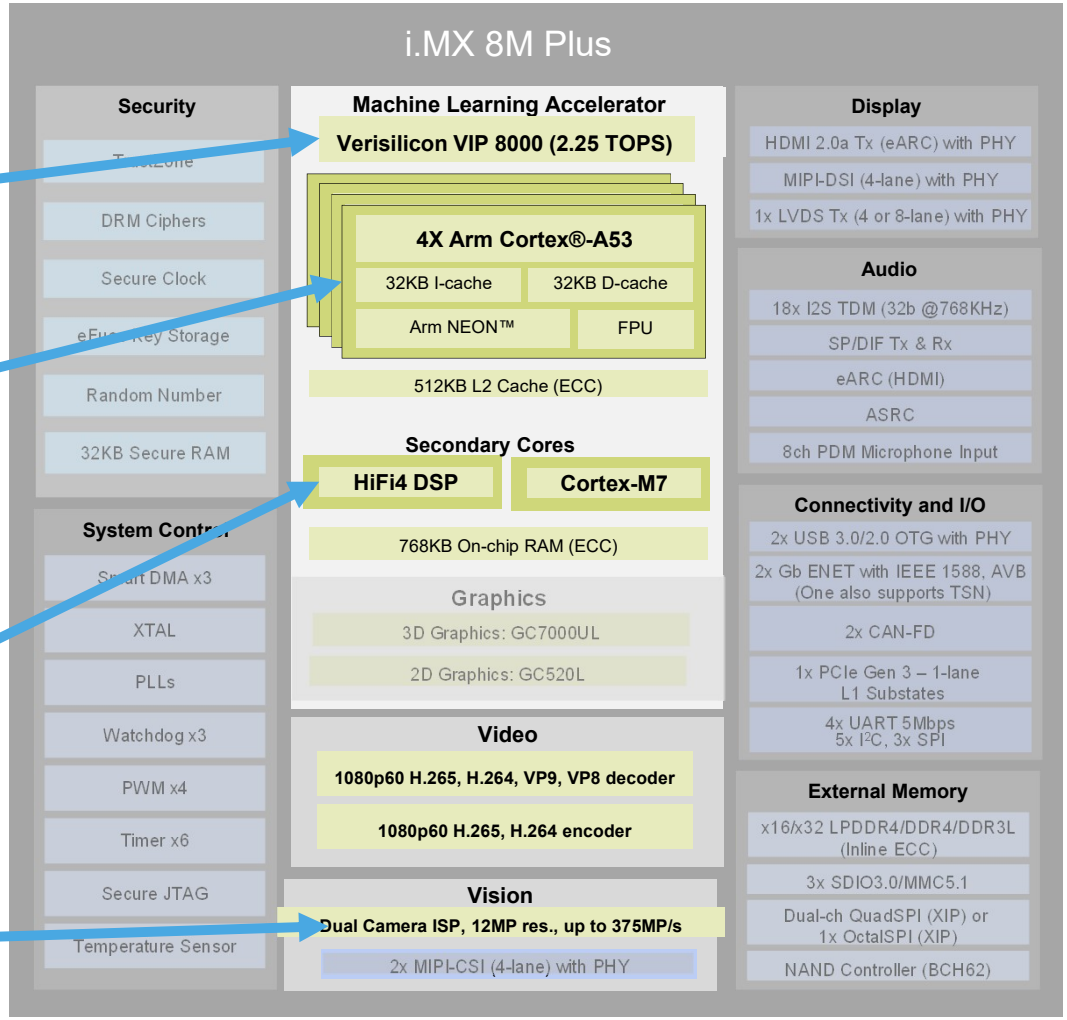
- Primary Use: Speech command recognition, object detect/classification

Cortex-M7+HiFi4 DSP (800MHz)

- Primary Use: Keyword detection, sensor fusion

2 channel Image Signal Processor (ISP)

- Primary Use: Scaling, dewarping, image enhancement



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DR. FRITZ DIERKS

DIRECTOR R&D – BASLER AG

EXTERNAL

NXP

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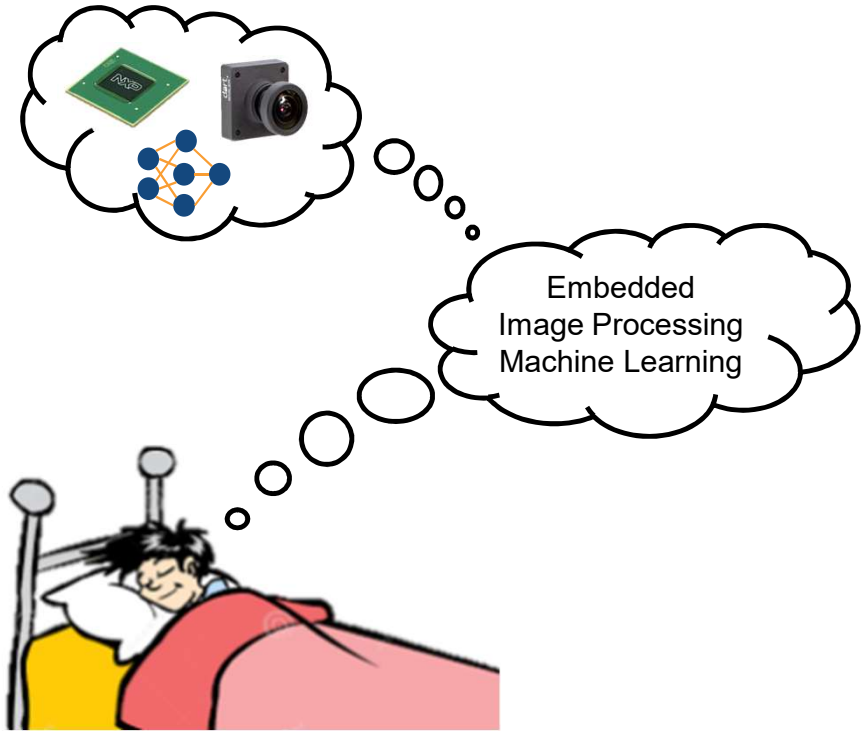
HOW TO MAKE YOUR CUSTOMER'S DREAMS COME TRUE



Your customers dream of a powerful, low cost, embedded vision system using machine learning?

Consider NXP's i.MX 8M Plus applications processor with a Basler camera!

Topics covered:

- Vision System Overview
- Available Camera Technology
- ML Programming Support
- Next Steps

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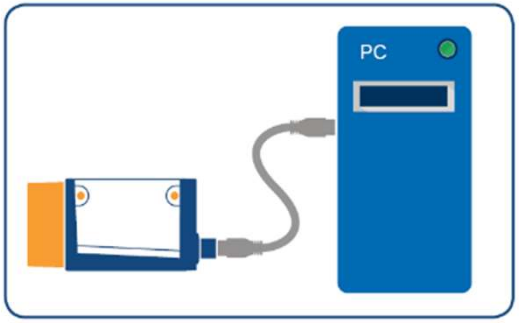
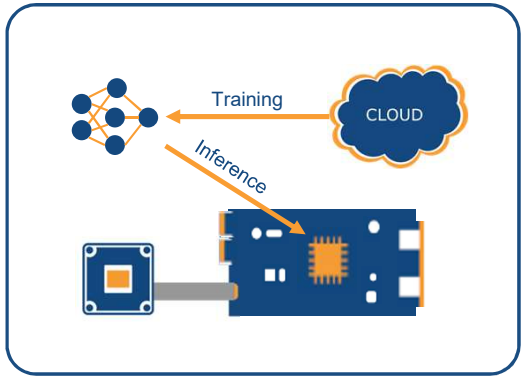
MACHINE LEARNING FOR VISION SYSTEMS





Classic Image Processing

- Huge base of algorithms and libraries
- Optimized for CPUs
- Classic system consists of camera and PC
- Performance growth driven by Moore's Law

➔ CPU performance growth is stalling

Machine Learning (ML) based Image Processing

- ML is still at the very beginning
- Two steps required: training and inference
- Training scales best by using cloud services
- For in-process inference CPUs can be too slow

➔ Use HW accelerators like the NPU*) of the i.MX 8M Plus

➔ ML drives Vision from PC to Embedded

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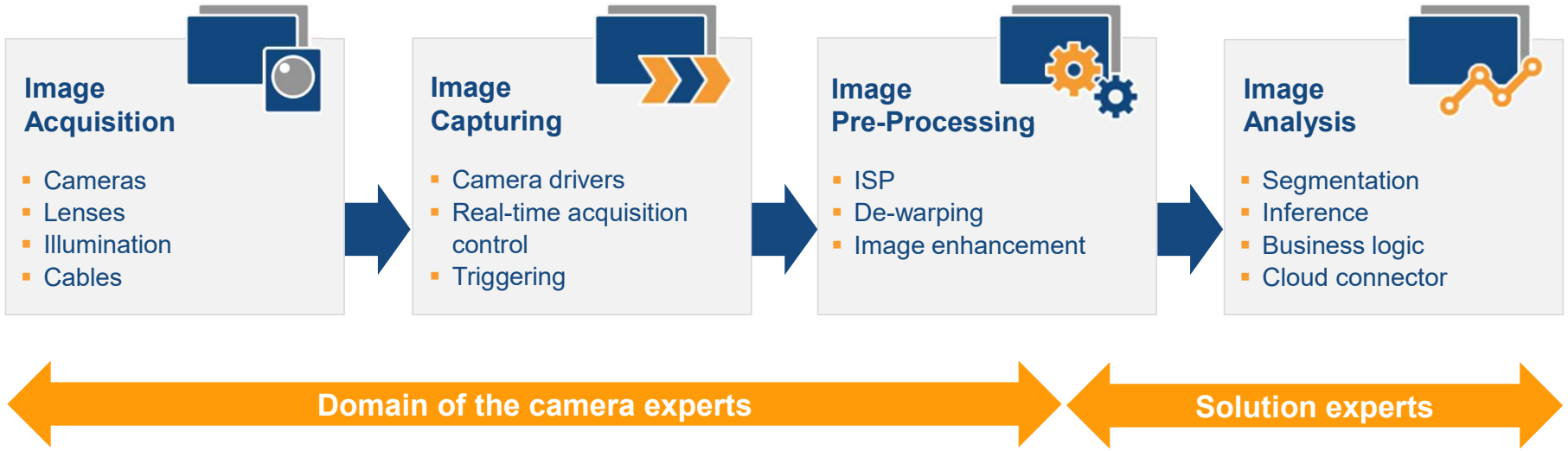
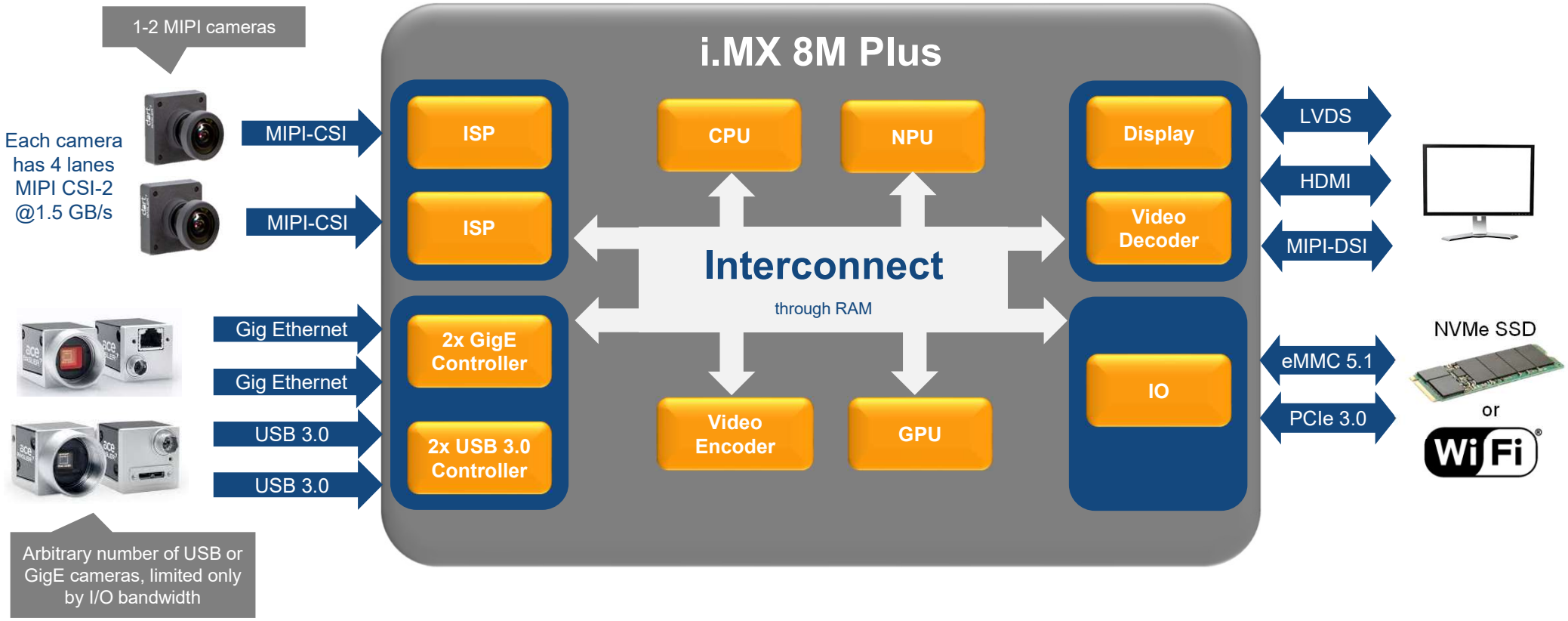
*) NPU = Neural Processing Unit

ELEMENTS OF A VISION SYSTEM



- Spending some effort on image acquisition can considerably lower the image analysis effort.
- Make sure the desired information is clearly visible in the image

I.MX 8M PLUS CAMERA SYSTEM USAGE



I.MX 8M PLUS REFERENCE CAMERA

Production Ready Camera

- i.MX 8M Plus (→ details next slide)
- Focus on quality and stability for use in industrial applications
- Longevity for design in business
- Short lead time < 3 weeks
- High production capacity > 600k p.a.

World Wide Customer Support

Customization

- Customization
- Sensor integration
- Customer features
- ISP tuning

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Basler Add-on Camera Kit:

- **Dart Camera module**
  >> designed for mass production
- **M12 Lens**
  >> exchangeable
- **Mini-SAS Adapter**
  >> for Basler dart BCON for MIPI standard connector
- **Flat flex cable**
  >> 200mm length

Camera Driver

- V4L2 support
- Integrated on NXP BSP

Pylon Software Suite

- Unified SDK for
  - Windows® and Linux®
  - PC and embedded

pylon 6 V4L2

- Extended Machine Vision Features
  - HW triggering
  - ISP Tuning
  - Custom

Embedded Vision Solutions

- Consulting and PoC
- System design and development
- Production and life cycle management

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LATEST SENSOR TECHNOLOGY

PREMIUM 4K COLOR CMOS SENSOR WITH SUPERB HDR PERFORMANCE

- 8MP (3840 x 2160)
- 2.1µm Back Side Illuminated (BSI) pixel
- Electronic rolling shutter
- Support major video formats
  8M 30fps, 4K 56fps, 1080P 120fps
- High Dynamic Range (HDR) support
  - 3 exposure HDR mode with on chip reconstruction
  - 120dB dynamic range

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IMAGE SIGNAL PROCESSOR (ISP)

ISP Tasks

- Most sensors use color mosaic filters to retrieve color information
- The basic task of the ISP is to convert the mosaic image to a true color format like YUV or RGB
- In addition the ISP does a lot of image enhancements, for example
  - Defect pixel correction
  - Color correction
  - Lens correction
  - 3A = Auto exposure | white balance | focus
  - High dynamic range processing

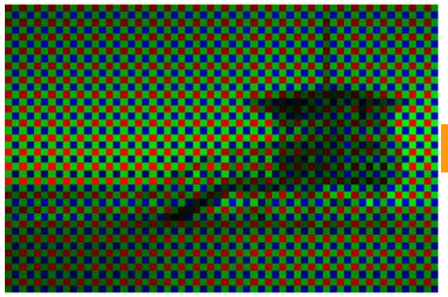


Image Sensor Output

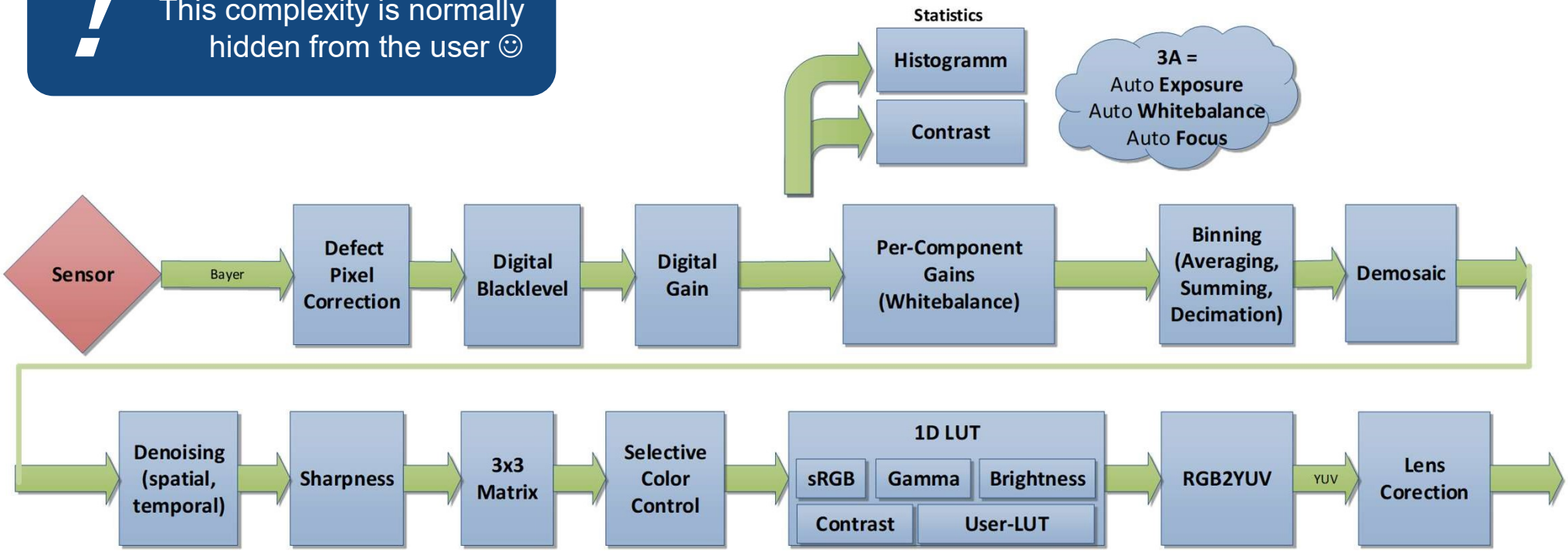
ISP Output

ISP Tuning

- Basler pylon SDK allows customers to fine tune ISP parameters themselves
- Custom ISP tuning such as lens calibration, is available as service

ISP DATA FLOW

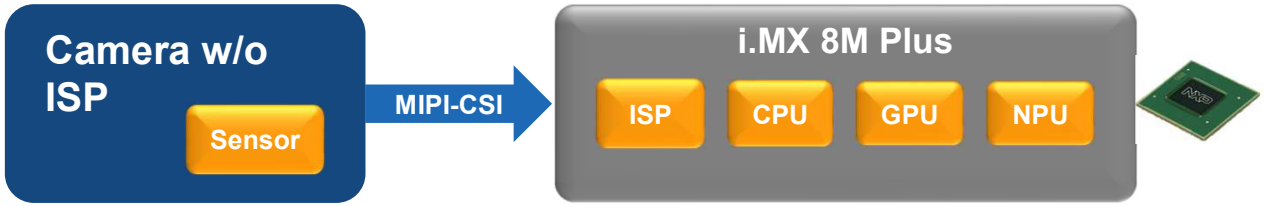
! This complexity is normally hidden from the user ☺



DIFFERENT PLACEMENTS OF THE ISP IN THE SYSTEM

dart

daA2500-60mc	5 MPx @ 60 fps
daA3840-30mc	8 MPx @ 30 fps

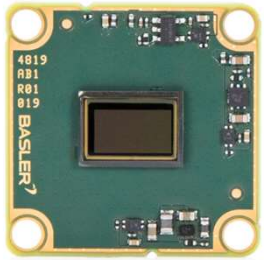


dart

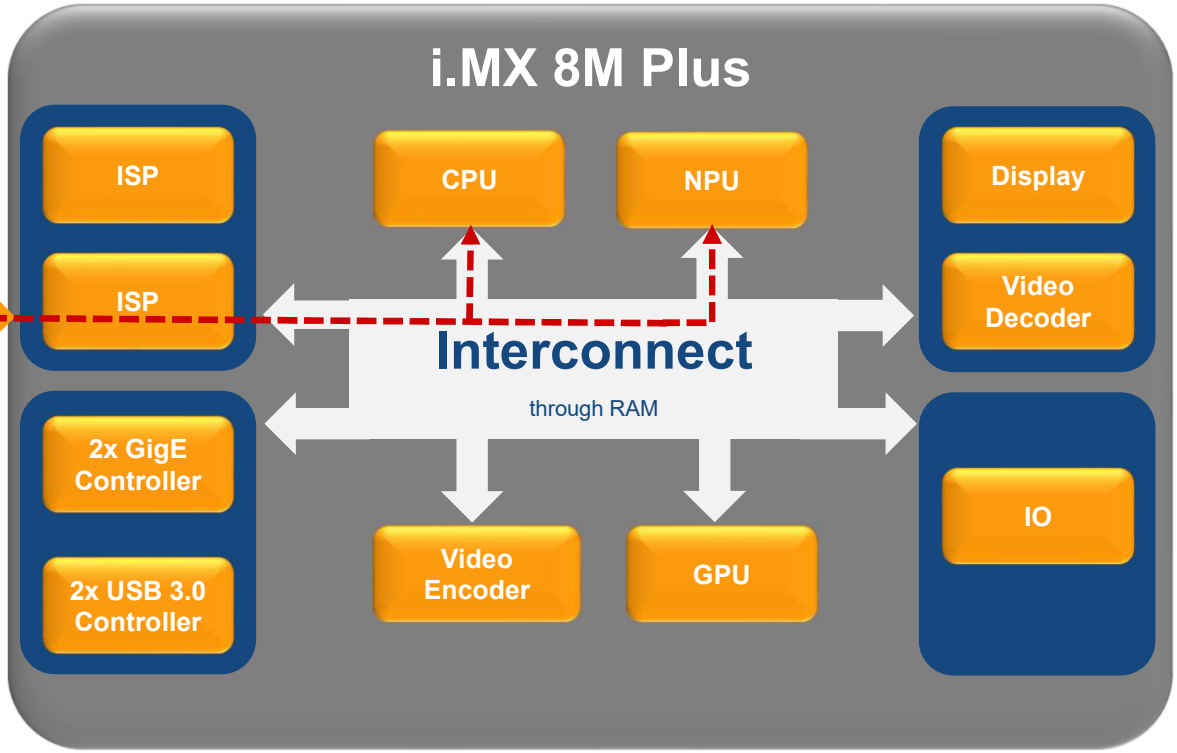
daA2500-60mci	5 MPx @ 60 fps
daA4200-30mci	13 MPx @ 30 fps

More to come …

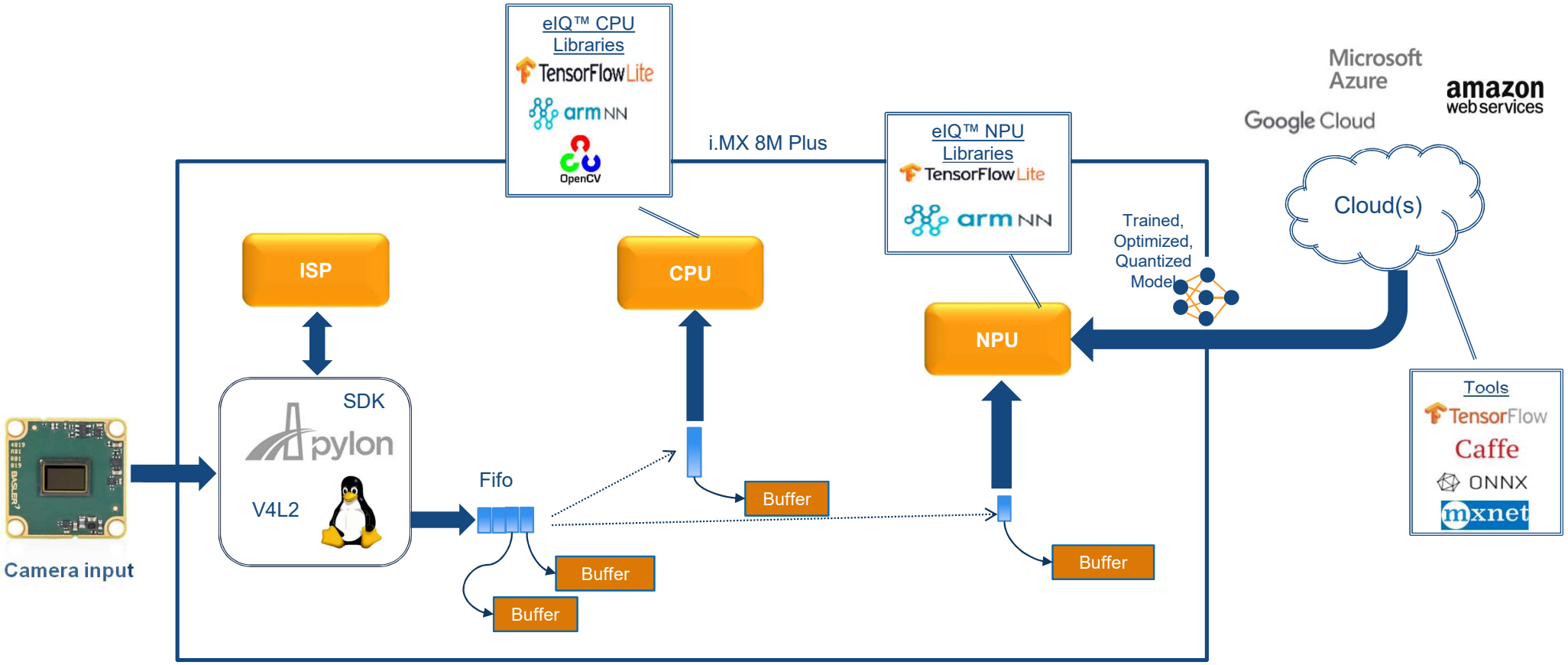
DATA PATH FROM SENSOR TO NPU - HARDWARE



video data

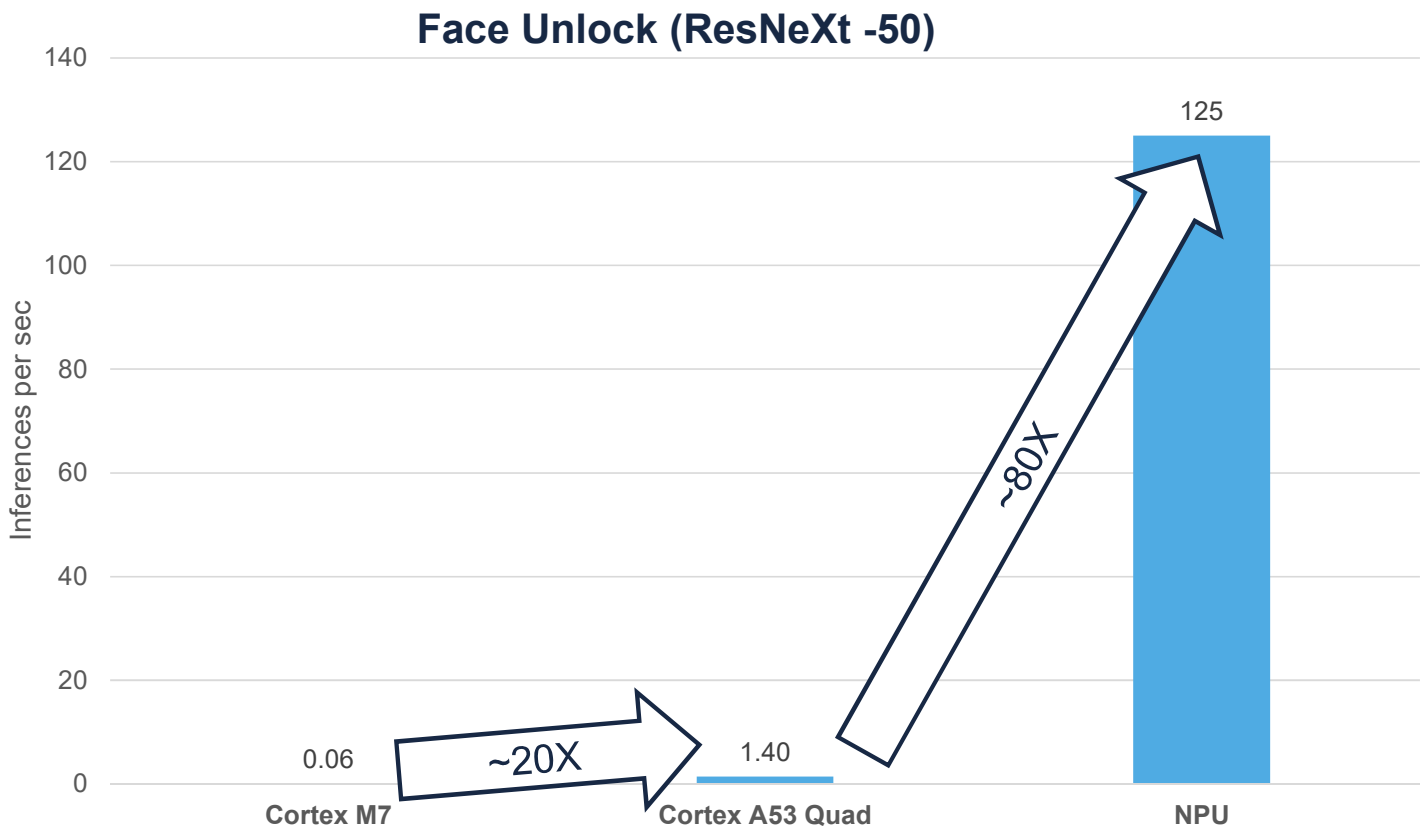


DATA PATH AND TOOLS / LIBRARIES



Buffer handling can also be done using gstreamer

I.MX 8M PLUS NPU PERFORMANCE



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MACHINE LEARNING ON THE EDGE

Fields of Application

- Sports Analysis
- Smart Home & Building
- Entertainment & Gaming
- Head Pose Detection

RESOURCES

- Product page i.MX 8M Plus applications processor
- 4K MIPI Camera for i.MX 8M Plus applications processor
- i.MX 8M Plus applications processor Fact Sheet
- Adding vision to the i.MX 8M family
- Technology Blog: Why Add an ISP and Machine Learning to the i.MX 8M Family

- eIQ™ Machine Learning Software Development Environment
- Community: eIQ Software Community

QUESTIONS & ANSWERS

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